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HARDTACK

April - October 1958

Project 26.4

SURFACE MOTIONS FROM A SERIES OF UNDERGROUND NUCLEAR TESTS

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Report to the Test Director

SURFACE MOTIONS FROM A SERIES OF UNDERGROUND NUCLEAR TESTS

By

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Department of Commerce
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ABSTRACT

Ground effects resulting from Blanca, Logan, Evans, Tamalpais and Mars events of HARDTACK Phase II underground explosions were measured by strong-motion and teleseismic seismographs out to distances of nearly 100 miles. In addition, many temporary seismographs were operated by a number of organizations to distances of nearly 2400 miles, and routine seismographs continued to operate on a world-wide basis. Some of the results are given in this report. For safety purposes, predictions of ground effects, using formulas derived by the U. S. Coast and Geodetic Survey from pre-Rainier HE tests and modified slightly as a result of the Rainier tests, hold true with reasonable accuracy.

CONTENTS

INTRODUCTION

OBJECTIVE

The main objective of Project 26.4 Operation Hardtack Phase II was to determine seismic effects of the underground nuclear events of Tamalpais, Logan, Evans, and Blanca by:

1. Recording ground surface accelerations and/or displacements[1] at up to twelve temporary strong-motion stations in the range 2,000 to 50,000 feet of each event.
2. Recording ground surface displacements at up to six temporary teleseismic stations in or near towns within 150 miles of the project.
3. Obtaining reports and/or copies of records from many established, continuously operating teleseismic stations.

BACKGROUND

The present Project 26.4 Operation Hardtack II is a sequel to Project 26.4d of Operation Plumbbob[2], where ground surface accelerations and displacements of Event Rainier were measured. Results from Project 26.4d suggested that the following formulas might have merit, at least for a rough prediction of acceleration and displacement attenuation with distance:

$$\text{Log } a = 0.75 \log W + 3.98 - 2 \log D \text{ (all distances)}$$
$$\text{Log } A = 0.75 \log W - 2.58 - 2 \log R \text{ (0 to 3 km)}$$
$$\text{Log } A = 0.75 \log W - 2.92 - \log R - 0.006\, R \text{ (3 to 160 km)}$$
$$\text{Log } A = 0.75 \log W - 4.58 - 0.5 \log R - 0.0025\, R \text{ (160 to 1,000 km)}$$

where
- a maximum acceleration, single-component (gravity)
- A maximum displacement, single-amplitude, single-component (centimeters)
- W equivalent high explosive (tons)
- D distance to explosion (feet)
- R distance to explosion (kilometers)

The present project provides additional seismic data on which further development of such formulas can be based.

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[1] The word "displacement" as used in this report means transient displacement and should not be confused with permanent displacements that may have occurred.

[2] D. S. Carder, W. K. Cloud, L. M. Murphy and J. H. Hershberger, "Surface Motions from an Underground Explosion," Operation Plumbbob, WT-1530, November 1958, U. S. Coast and Geodetic Survey.

PROCEDURE

SHOT PARTICIPATION

Fifteen temporary strong-motion seismograph stations were available from which seismic effects could be measured. (See Figure 1 for locations, and Table 1 for geographic coordinates.) Each station consisted of an unreinforced concrete pier (or floor slab) well grouted to a firm outcrop of local foundation material and covered with a light-proof shelter. Station locations were a compromise between the scientific optimum and economically feasible. However, locations were selected such that the larger events could be monitored from several directions and at least one station was located on each of the geologic formations in the area.

In addition to the strong-motion stations, six temporary teleseismic stations were established at locations shown in Figure 2. The purpose of the six stations was, primarily, to reassure the public on safety of underground nuclear tests.

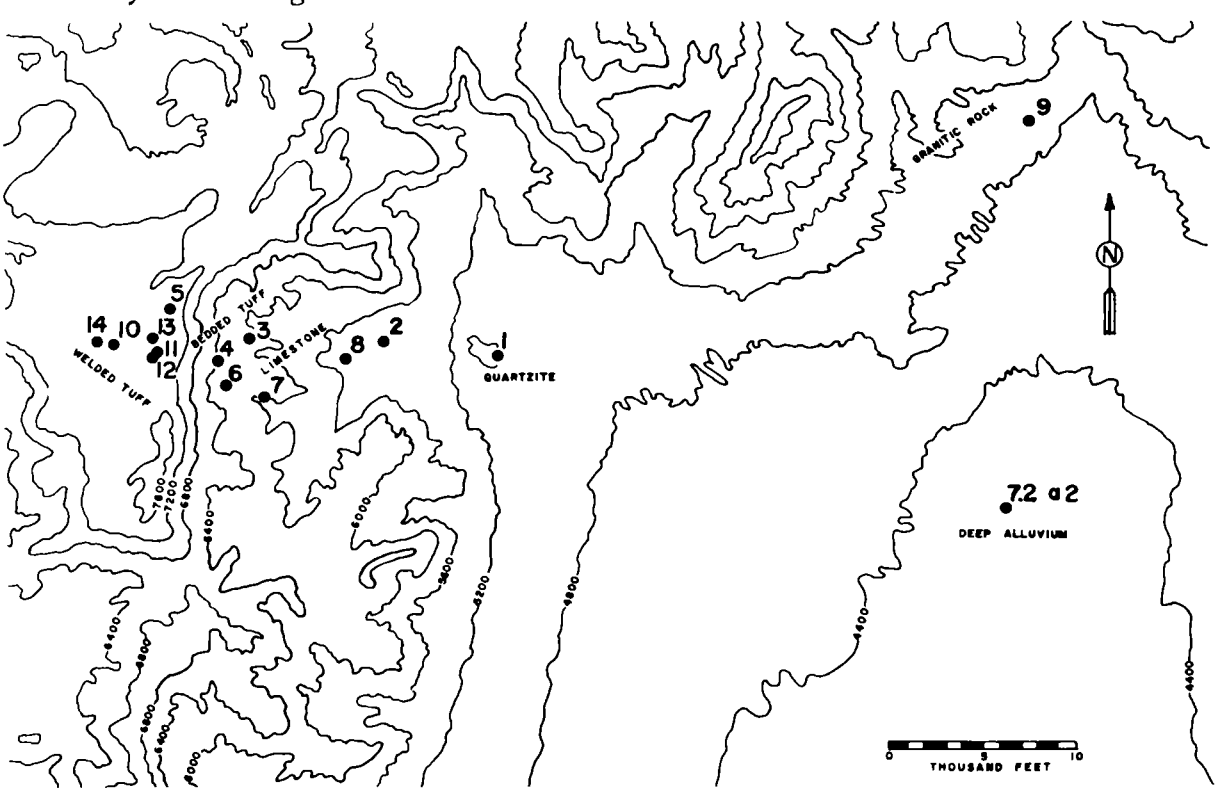


Figure 1 Strong-Motion Seismograph Stations

For distance coverage, arrangements were made for participation of established teleseismic stations.

TABLE I STATION AND EVENT COORDINATES AND ELEVATIONS, NEVADA GRID

Station or Event	North	East	Elevation
	feet	feet	feet
1200.01	889 049	652 507	5039
1200.02	890 006	646 497	5353
1200.03	890 482	639 350	6010
1200.04	889 314	637 670	6448
1200.05	892 280	634 920	7425
1200.06	887 820	637 900	6115
1200.07	887 230	640 050	5860
1200.08	889 106	644 554	5473
1200.09	902 423	679 923	5014
1200.10	890 361	631 769	7379
1200.11	889 876	634 381	7502
1200.12	889 646	634 194	7503
1200.13	890 538	634 072	7441
1200.14	890 243	630 932	7424
7.2a1*	867 338	679 822	4280
7.2a2	881 276	678 576	4340
Blanca	886 988	635 353	6140
Logan	886 417	635 686	6136
Evans	890 232	634 540	6620
Tamalpais	890 402	635 788	6616

* Station not instrumented.

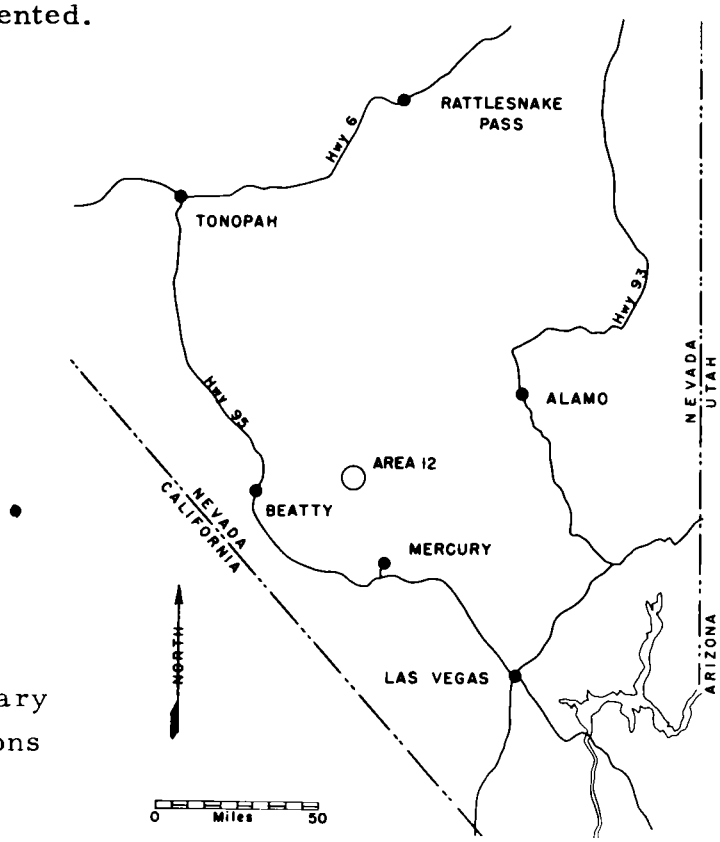


Figure 2 Temporary Teleseismic Stations

INSTRUMENTATION

Strong-motion instruments installed for Project 26.4 were of the type used by the Coast and Geodetic Survey to record strong earthquake motion, and also were used to record the Rainier event in 1957. Each contained a camera, measuring elements, timing devices, and circuitry for remote control. Measuring elements were compound pendulums, whose relative motion to the earth was directly recorded on photographic tape by means of optical levers. Pendulums were calibrated by tilt tests prior to installation, and by period and damping tests after installation. During operation 1/2-second time marks were placed on the records by clocks at each instrument, and also by a central chronometer wire linked to each instrument.

For each event, strong-motion instruments were wired to start on either a -5 second or a 2-1/2 second closure of EG&G relays, and to stop on opening of mechanical circuit breakers after several minutes' operation. Closure of an EG&G zero-time relay was used to reference firing time on each record.

The six teleseismic stations near the test site were instrumented with vertical Wilson-Lamison seismographs. In these instruments a coil attached to the pendulum boom and free to move in the field of a permanent magnet generated voltages sufficient to deflect a sensitive galvanometer. Deflections of the galvanometer and time marks were recorded by optical methods on photographic paper wrapped around a slowly revolving and translating drum. As used, the instruments were started manually several hours prior to each recorded event and were time-correlated by means of WWV world time signals.

RESULTS

STRONG-MOTION

Contact prints of the larger strong-motion seismograph records obtained from five events of Operation Hardtack II are included as Appendix A to this report (Blanca, Logan, Evans, Tamalpais, and Mars). Instrumental constants and other data necessary for analyses are shown on the prints.

Maximum accelerations and displacements based on preliminary analyses of the records are given in Tables 2, 3, 4, and 5. Yields shown in the tables for Blanca, Logan, and Evans were calculated from the Rainier acceleration formula written in the form

$$\text{Log } W = (\log a + 2 \log D - 3.98) \times 1.33$$

where W equivalent weight of HE (tons)
a maximum single-component acceleration (gravity)
D slant distance to zero (feet)

The yields so calculated are merely intended to illustrate variation that might be expected from the method of estimation by this formula.

Maximum single-component accelerations given in the tables for Blanca, Logan, and Evans are graphically summarized in Fig. 3. In the figure solid slant lines represent accelerations calculated from

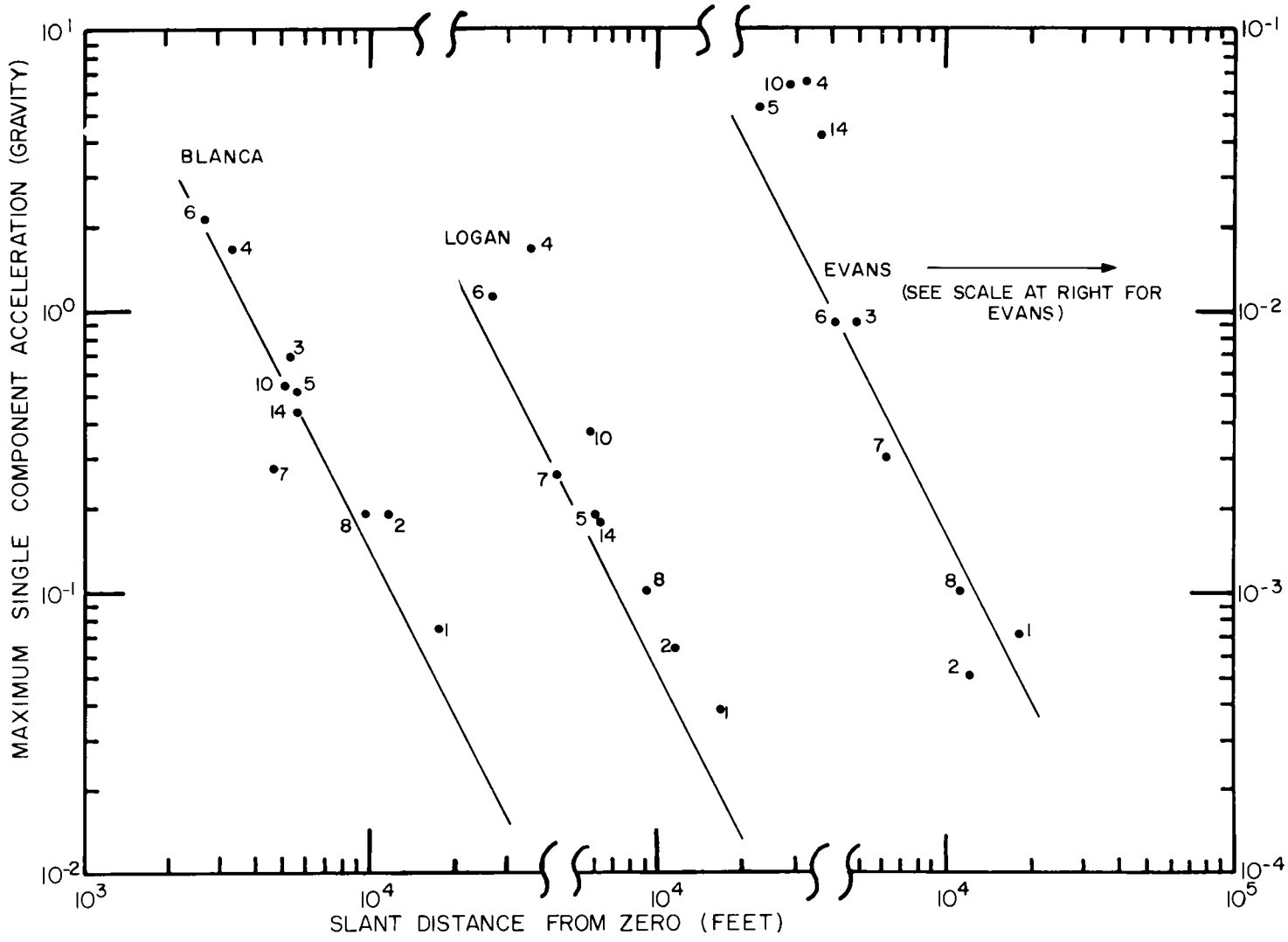


Figure 3 Maximum Acceleration vs Distance - Blanca, Logan and Evans

AEC reported yields by means of the Rainier formula in the form

$$\text{Log } a = 0.75 \log W + 3.98 - 2 \log D$$

where a acceleration (gravity)
W yield reported by AEC (tons)
D slant distance to zero (feet).

Blanca:	23 kt
Logan:	4.5 kt
Evans:	45 tons

In the final report, displacement data from strong-motion instruments and results from distant Wood-Anderson stations will be analyzed, data given in this report refined, and results of certain spectrum analyses reported.

TELESEISMIC DATA

Teleseismic data that are presently available are listed in Tables 6, 7, and 8. Table 6 is mislabeled in that local shocks are not generally considered teleseisms. However, since recordings were by teleseismic instruments, these data will be listed under this heading.

In Table 6, the travel time data (d - 0) are believed reliable within 0.3 sec. The ground amplitude data on the other hand may have an error toleration of more than 20 percent, and in the case of the larger shots, they are not always available because of too high magnifications.

Tables 7 and 8 list data from world teleseismic stations and include the distances to these stations, arrival times of the leading waves, and directions of first recognizable motion, whether compression or rarefaction. The direction of first motion often is a matter of judgment, and some readings may be in error.

CONCLUSIONS

It is too early at this time to give an accurate appraisal of Hardtack II seismic data. However, if the preliminary data from Blanca is a criterion, seismic effects were about as predicted, using empirical formulas from Rainier data, except that attenuation for surface waves beyond 200 km may have been higher than the formula for that distance would indicate.

Results obtained from Logan and the smaller shots require considerable more thought before appraisal. Preliminary seismic data on Logan, for example, indicate about double the yield obtained by radiochemical methods.

Evaluation of the present seismic project and recommendations for future seismic studies will be withheld until after the test data have received a more thorough review and extended analyses.

TABLE 2 BLANCA - MAXIMUM ACCELERATIONS AND DISPLACEMENTS

Station, Distance (slant range), and Foundation	Component*	Maximum Acceleration	Approximate Period	Maximum Displacement	Approximate Period	Calc. Yield
		g	sec	cm	sec	kt
1200.09	V	- - -	- -	- - -	- -	
47,181 ft	R	- - -	- -	0.128	1.4	
Granitic rock	T	- - -	- -	.088	1.4	
7.2a2	V	- - -	- -	- - -	- -	
43,635	R	- - -	- -	0.431	1.4	
Deep alluvium	T	- - -	- -	.137	1.4	
1200.01	V	0.074	0.2	.332	0.6	
17,311 ft	R	.054	.2	.618	1.3	31.2
Quartzite	T	.073	.2	.358	0.6	
1200.02	V	.14	.1	.400	.6	
11,570 ft	R	.19	.1	.645	.5	37.4
Limestone	T	.17	.1	.314	.6	
1200.08	V	.19	.1	.53	.7	
9,463 ft	R	.14	.1	1.21	.8	21.9
Limestone	T	.17	.1	0.66	.7	
1200.14	V	.44	.2	1.29	?	
5,644 ft	R	.26	.2	5.60	1.9	16.9
Welded tuff	T	.36	.1	2.11	2.2	
1200.05	V	.40	.1	2.16	1.4	
5,469 ft	R	.33	.2	4.75	0.9	19.4
Welded tuff	T	.52	.2	5.18	1.6	
1200.03	V	.69	.2	0.46	0.2	
5,310 ft	R	.69	.2	1.90	.5	26.0
Bedded tuff	T	.48	.1	0.50	.2	
1200.10	V	.54	?	1.63	.8	
5,081 ft	R	.38	0.3	5.12	1.9	16.8
Welded tuff	T	.50	.1	3.06	1.3	
1200.07	V	.27	.1	1.10	0.8	
4,710 ft	R	.27	.1	0.70	.6	5.6
Limestone	T	.28	.1	.32	?	
1200.04	V	1.67	1	3.30	0.5	
3,300 ft	R	1.04	.07	3.10	.6	23.9
Bedded tuff	T	1.37	.07	2.2	.5	
1200.06	V	2.10	.04	1.15	?	
2,679 ft	R	1.58	.07	2.00	?	18.6
Limestone	T	1.50	.04	3.80	0.4	

* V is vertical, R radial and T tangential.

TABLE 3 LOGAN - MAXIMUM ACCELERATIONS AND DISPLACEMENTS

Station, Distance (slant range), and Foundation	Component	Maximum Acceleration	Approximate Period	Maximum Displacement	Approximent Period	Calc. Yield
		g	sec	cm	sec	kt
1200.09	V	- - -	- -	- - -	- -	
47,057 ft	R	- - -	- -	0.046	1.3	
	T	- - -	- -	.044	1.3	
7.2a2	V	- - -	- -	.16	1.2	
43,234 ft	R	- - -	- -	.076	1.3	
	T	- - -	- -	- - -	- -	
1200.01	V	0.026	0.4	- - -	- -	
17,060 ft	R	.038	.2	0.16	0.8	12.3
	T	.032	.5	.25	.7	
1200.02	V	.055	.3	.36	.6	
11,417 ft	R	.063	.2	.33	.7	8.3
	T	.049	.2	.24	.5	
1200.08	V	.10	.2	.33	.5	
9,289 ft	R	.08	.2	.44	.7	8.7
	T	.06	.2	.35	.5	
1200.14	V	.18	.2	.22	.4	
6,241 ft	R	.14	.2	1.73	1.7	6.7
	T	.13	.2	1.33	1.2	
1200.05	V	.13	.3	1.45	0.8	
6,056 ft	R	.14	.3	1.66	1.3	6.7
	T	.19	.2	1.47	1.2	
1200.10	V	.34	.1	0.67	0.6	
5,701 ft	R	.22	.3	1.81	1.7	14.3
	T	.38	.1	1.62	1.1	
1200.03	V	Instrument failure		0.25	?	
5,474 ft	R			.87	0.5	
	T			.36	.6	
1200.07	V	0.20	0.1	.58	.7	
4,446 ft	R	.26	.1	.64	.7	4.4
	T	.12	.1	.28	?	
1200.04	V	.80	.1	1.25	?	
3,527 ft	R	1.68	.1	6.12	0.6	28.8
	T	1.03	.2	2.78	.6	
1200.06	V	0.83	.3	Instrument failure		
2,621 ft	R	1.12	.04			7.6
	T	0.55	.1			

TABLE 4 EVANS - MAXIMUM ACCELERATIONS AND DISPLACEMENTS

Station, Distance (slant range), and Foundation	Component	Maximum Acceleration	Approximate Period	Maximum Displacement	Approximent Period	Calc. Yield
		g	sec	cm	sec	tons
1200.09	V	- - -	- -	- - -	- -	
47, 019 ft	R	- - -	- -	0.00008	- -	
	T	- - -	- -	.0001	- -	
7.2a2	V	- - -	- -	- - -	- -	
44, 995 ft	R	- - -	- -	0.00008	- -	
	T	- - -	- -	.00008	- -	
1200.01	V	0.0007	- -	- - -	- -	70
18, 075 ft	R	.0005	- -	- - -	- -	
	T	.0004	- -	- - -	- -	
1200.02	V	- - -	- -	- - -	- -	15
12, 026 ft	R	0.0005	- -	- - -	- -	
1200.08	V	.001	- -	- - -	- -	24
10, 141 ft	R	.0008	- -	- - -	- -	
1200.07	V	.002	- -	- - -	- -	30
6, 320 ft	R	.003	- -	- - -	- -	
	T	.003	- -	- - -	- -	
1200.03	V	.005	- -	- - -	- -	63
4, 854 ft	R	.009	- -	- - -	- -	
	T	.008	- -	- - -	- -	
1200.06	V	.009	- -	- - -	- -	42
4, 166 ft	R	.009	- -	- - -	- -	
	T	.009	- -	- - -	- -	
1200.14	V	.042	0.1	0.016	- -	239
3, 698 ft	R	.031	.1	.010	- -	
	T	.040	.1	.022	- -	
1200.04	V	.033	.2	.008	- -	417
3, 266 ft	R	.065	.2	.03	- -	
	T	.065	.2	.04	- -	
1200.10	V	.049	.1	- - -	- -	210
2, 877 ft	R	.058	.1	- - -	- -	
	T	.063	.1	- - -	- -	
1200.05	V	.034	.1	0.05	- -	83
2, 235 ft	R	.031	.1	.05	- -	
	T	.052	.1	.07	- -	

TABLE 5 TAMALPAIS AND MARS - MAXIMUM ACCELERATIONS AND DISPLACEMENTS

Station, Distance (slant range), and Foundation	Component	Maximum Acceleration	Approximate Period	Maximum Displacement	Approximate Period
		g	sec	cm	sec
1200.09	V	- - -	- -	- - -	- -
45, 771 ft	R	- - -	- -	0.00031	1.1
	T	- - -	- -	.00039	0.5
7.2a2	V	- - -	- -	- - -	- -
43, 812 ft	R	- - -	- -	0.0016	1.1
	T	- - -	- -	.0011	0.8
1200.05	V	0.098	0.1	.27	.7
2, 222 ft	R	.064	.1	.19	.6
	T	.052	.1	.28	.6
1200.04	V	.18	.2	.17	.3
2, 180 ft	R	.18	.1	.44	.4
	T	.33	.1	.45	.3
EVENT MARS:					
1200.04	V	0.038	.1	.033	.3
1, 944 ft	R	.049	.2	.052	.4
	T	.049	.2	.047	.3

TABLE 6 LOCAL TELESEISMIC DATA

Station	Shot	d - 0	P - Wave			S & Surface Waves	
			A_1+	A_2-	A_m	Period	A_m
		sec	microns			sec	microns
Alamo	Tamalpais	16.4	0.01	0.01		1.0	0.6
	Logan	16.4	0.5	2.1	?	1.3	?
	Blanca	16.5			?		?
Beatty	Tamalpais	10.4	0.09		0.3	1.2	0.45
	Logan	10.5	+	-4.5	4.5	1.5?	20?
	Blanca	10.4	8.0	12	22	1.0?	22?
Desert Rock	Logan	*	1.2	5.0	5.0	1.2	8.5
	Blanca	10.7	1.7	6.6	21	?	21?
Las Vegas	Tamalpais	26.9			0.2		0.3
	Logan	25.6	0.3	1.1	9	1.5	25
		26.8					
Rattlesnake	Tamalpais	23.8	0.01	0.02	0.5	1.0	0.5
	Logan	23.7	0.3	0.7	7.6	1.0	7.6
	Blanca	23.6	1.2	2.2	28	1?	28
Tonopah	Tamalpais	23.2	0.03	0.3	3.0	1	0.3
	Blanca	23.1	5.4	3.3	14	1 -	18

Instruments - Wilson Lamison Vertical
Symbols in Column Headings: A_1^+ - Zero to peak amplitude of leading wave; A_2^- - Peak to trough amplitude of leading wave; A_m - Maximum zero to peak amplitude in pulse; d - 0 - Elapsed time after shot zero.
* No time control

TABLE 7 SUMMARY OF TELESEISMIC RESULTS - BLANCA AND LOGAN

Station	Miles	Blanca - P	First Motion	Logan - P	First Motion
Beatty	36.4	07-00-10.4	C	22-00-10.5	C
Desert Rock	39.7	00-10.7	C	00-(07)	
Alamo	59.3	00-16.5	C	00-16.4	C
Lockes	81.1	00-23.6	C	00-23.7	C
Tonopah	82.5	00-23.1	C	NR	
Las Vegas	91.8	00-27	R	00-25.6	C
Tinemaha	112.3	00-30	C	00-30	C
Boulder City	112.6	00-29	C	00-30	C
Hoover Dam	115.2	NR		NR	
Haiwee	121.3	00-32	C	00-32	C
China Lake	122.7	00-31	C	00-31	C
Eureka	160.4	00-40	C	00-40	C-R
Isabella	165.9	00-40	C	00-40	C
Woody	179.6	00-44	C	00-44	C
Fresno	201.0	00-48	C	00-48	C
Ft. Tejon	219.2	00-52	R	00-52	C
Dalton	227.3	00-53	C	00-53	C
Mt. Wilson	230.0	NR		00-53	
Riverside	230.4	00-54	C	00-53	C
King Ranch	236.0	NTC	C	NTC	C
Pasadena	237.5	00-55	C	00-55	C
Hayfield	241.8	00-55	C	00-56	C
Reno	254.0	00-59	C	00-59	R
Palos Verdes	263.0			01-02	
Palomar	267.5	01-01	C	01-01	C
Santa Barbara	273.1	NTC	C	01-(04)	-
Mt. Hamilton	300.0	01-08	C	01-08	C
Monterey	311.0	01-15			
Barrett	312.4	01-10	C	01-10	-?
Palo Alto	329.6	01-14	R	NR	
San Nicolas	329.9	01-13	C	01-13	R
Berkeley	335.9	01-16	C	01-16	C
Salt Lake City	340.6	01-19	C	01-19	R
San Francisco	345.9	01-22	?	NR	
Mineral	362.2	01-20	R	01-21	-
Ukiah	403.3	01-47	R	NR	
Logan	410.0	01-27	-		
Shasta	411.4	01-30	C	NR	
Tucson	457.2	01-39	R	01-39	R
Rifle	510.0	01-48	-	01-49	-
Boulder	622.3	02-14	C	02-14	C
Corvallis	630.5	NR		NR	
Laramie	636.5	02-16	C	02-16	C
Butte	638.0	02-20	C	02-20	R?
Boseman	643.7	NR		02-22	C
Hungry Horse	778.9	02-45	-	02-45	C
Seattle	785.9	NR		NR	
Rapid City	831.6	02-55	R	02-53	R
Lubbock	840.0	03-00	-	03-01	-
Victoria	863.4	03-13	C	NR	
Banff	965.0	03-24			

Table 7 (Continued)

Blue Hill	970.0	03-24		NR	
Dallas	1139.0	NR			
Lawrence	1146.7	03-53	-	NR	
Fayetteville	1222.9	04-09	C	04-09	C
Little Rock	1343.4	NR		NR	
Star Lake, Canada	1356.4	NR		04-35	-
Fort Madison	1358.0	04-33	-		
East Merrick, Canada	1390.8	NR		NR	
Florissant	1410.0	04-41	h	04-42	h
St. Louis	1418.0	04-41	h	04-42	C
Linko, Canada	1550.6	NR		05-01	?
Geraldton, Canada	1689.0	NR		NR	
Flynn Lake, Canada	1745.5	NR		NR	
Alpena		05-32			
Opasatika	1863.0	05-44	-	NR	
Buffalo	2040.0	06-38	-		
Chapel Hill	2055.8	06-09	-	NR	
Ottawa, Canada	2158.4	06-23	C	06-24	C
Shawnigan Falls, Canada	2301.5	06-40	C	NR	
College, Alaska	2309.9	06-42	C	06-42	C
Seven Falls	2393.5	NTC	R	06-56	R

Miscellaneous Data Reported by Telegraph

Duluth	1386	NR		NR	
New Orleans	1580	NR		NR	
Tacubaya, Mexico	1615	13-02	-	NR	
Spring Hill	1680	NR		04-58	-
Cleveland	1860	Late Reading	-	NR	
Morgantown	1960	05-58	-	NR	
Columbia	2000	NR		NR	
Front Royal	2160	Late Reading			
Palisades	2260	Surface Wave	-	Surface Wave	-
Fordham	2270	NR			
Weston	2410	NR		NR	
Resolute Bay, Canada	2680	07-26	-		
Honolulu, T.H.	2710	NR		NR	
Balboa Heights, C.Z.	3080	NR			
San Juan, P.R.	3320	Late Reading	-	NR	
Bogota, Colombia	3560	NR			
Kiruna, Sweden	4900	NR			
Huancayo, Peru	5120	10-25	-		
Matsushiro, Japan	5480	12-09	-		
Strasbourg, France	5680	NR			
Stuttgart, Germany	5680	12-21	-		
Pruhonice, Czechoslovakia	5760	12-26	-		
Rome, Italy	6150	Not Operating			

C - Compressional wave
R - Rarefactional wave
NR - No indication on the record
NTC - No time correction
\- Direction of first motion not determined
h Horizontal component

TABLE 8 SUMMARY OF TELESEISMIC RESULTS-TAMALPAIS AND EVANS

Tamalpais

Station	First Motion	Station	First Motion
Beatty	X	Mt. Hamilton	X
Alamo	C	Berkeley	No Record
Tonopah	C	Salt Lake City	X
Las Vegas	X	Ukiah	X
Lockes	C	Tucson	X
Boulder City	X	Boulder	X
Eureka	X	Butte	X
Haiwee	X	Hungry Horse	X
China Lake	X	Rapid City	X
Mt. Wilson	X	Lubbock	X
Pasadena	X	Lawrence	X
San Nicholas	X	Fayetteville	X

Note: Evans was detected only by strong motion stations shown in Figure 1.

C - Compressional wave
X - Shot detected but direction of first motion not determined

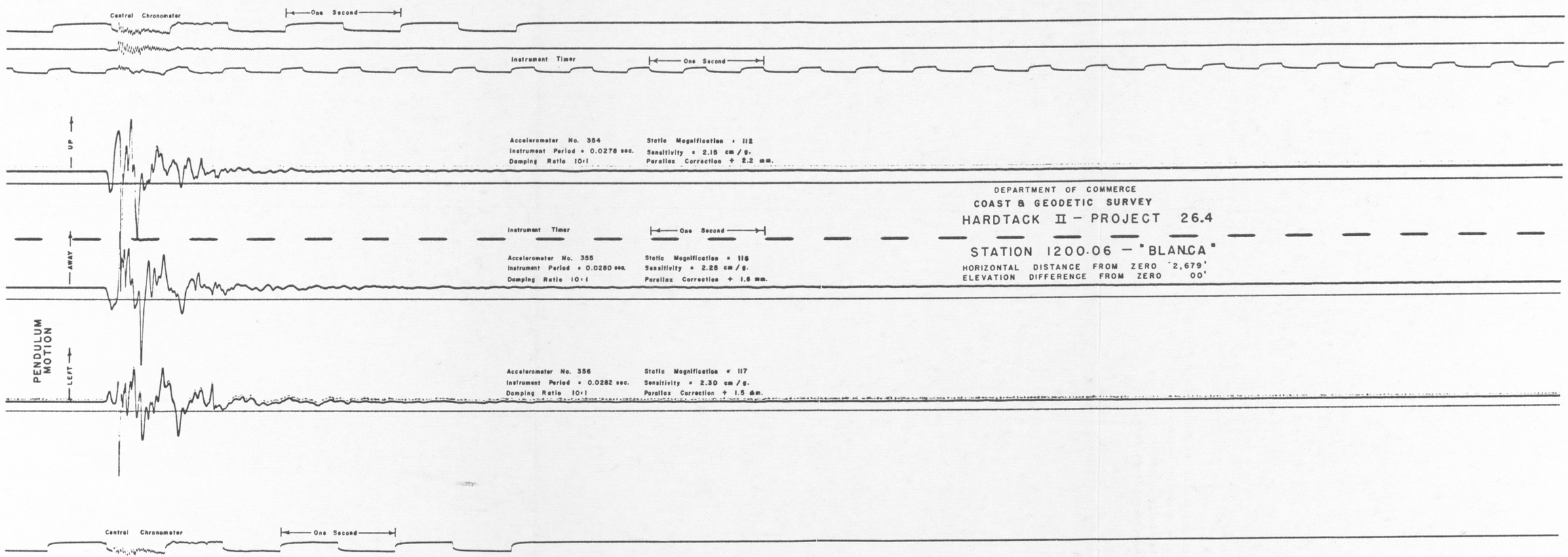
APPENDIX A

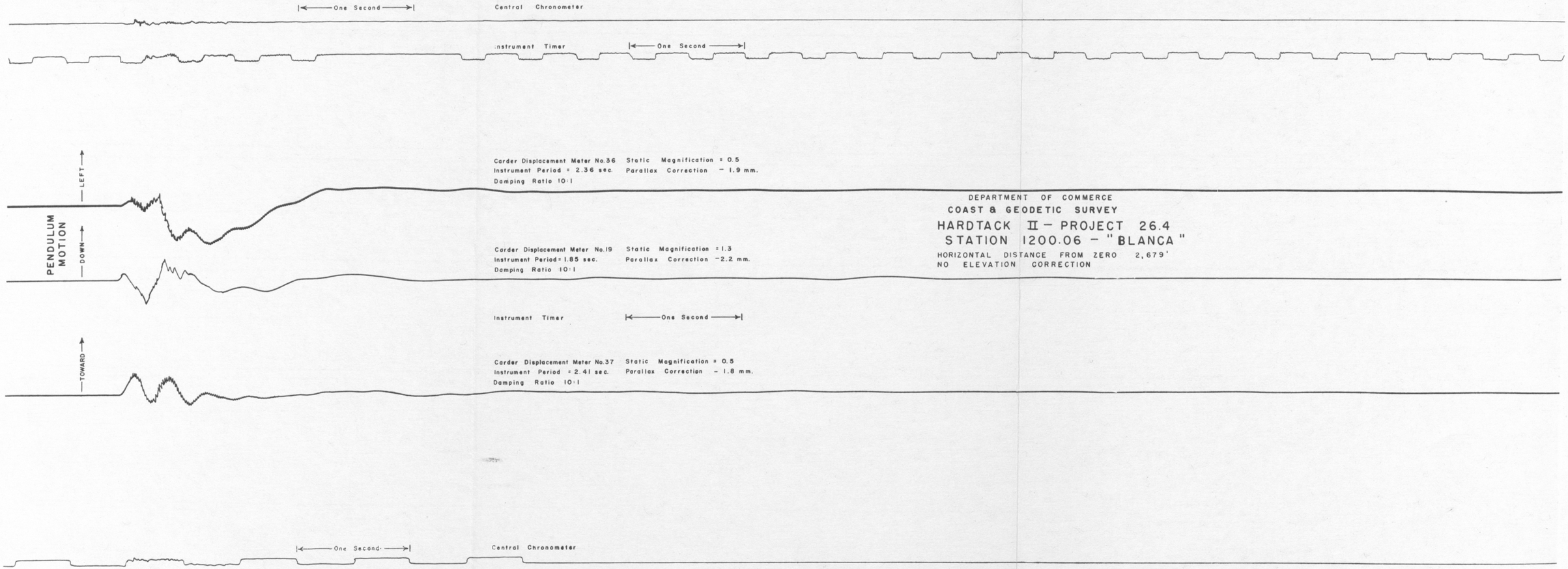
CONTACT PRINTS OF SEISMOGRAPH RECORDS

LIST OF SEISMOGRAMS

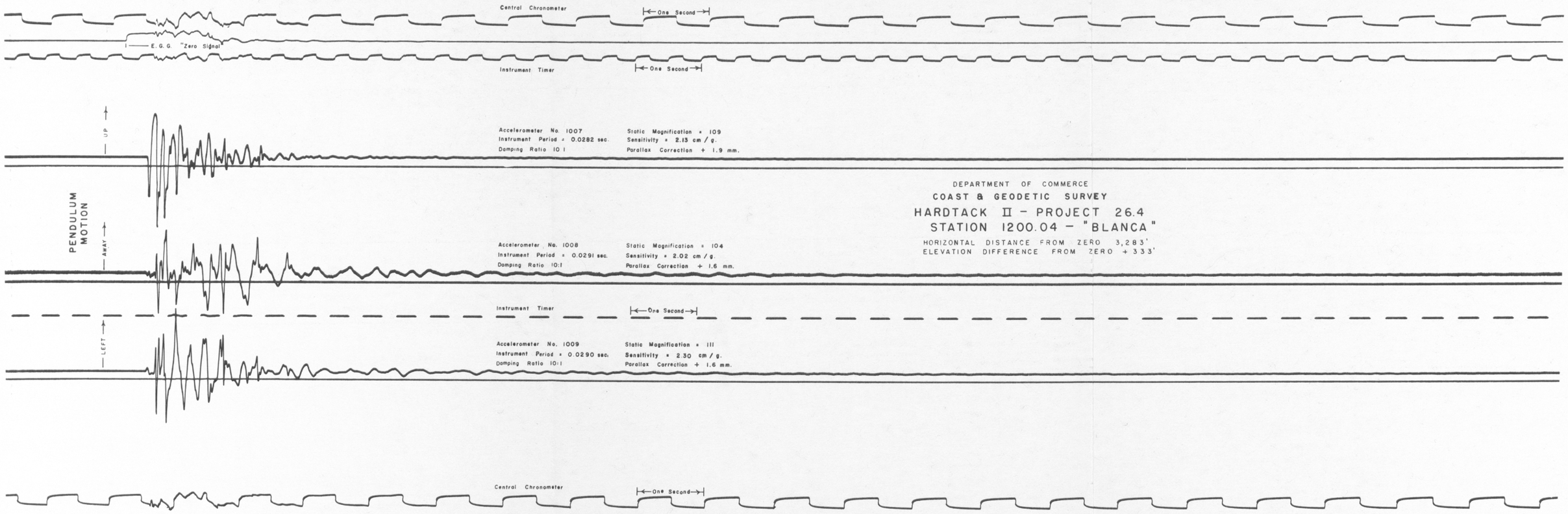
Station	Blanca	Logan	Evans	Tamalpais	Mars
1200.06	2,679′ A and D	2,621′ A	--	--	--
.04	3,283′ A and D	3,511′ A and D	3,262′ A	2,174′ A and D	1,925′ A and D
.07	4,703′ A and D	4,439′ A and D	--	--	--
.10	4,922′ A and D	5,539′ A and D	2,774′ A	--	--
.03	5,309′ A and D	5,473′ D	--	--	--
.05	5,310′ A and D	5,912′ A and D	2,083′ A	2,069′ A and D	--
.14	5,490′ A and D	6,103′ A and D	3,608′ A	--	--
.08	9,444′ A and D	9,267′ A and D	--	--	--
.02	11,545′ A and D	11,391′ A and D	--	--	--
.01	17,277′ A and D	17,025′ A and D	--	--	--
7.2a2	43,599′ D	43,197′ D	--	43,750′ D	--
1200.09	47,167′ D	47,044′ D	--	45,743′ D	--
Rattlesnake Station (near Lockes, Nev.)	T	T	--	T	--
Tonopah, Nev.	T	T	--	--	--
Hungry Horse, Mont.	T	T	--	--	--
College, Alaska	T	T	--	--	--
Tucson, Ariz.	--	T	--	--	--

Notes: A indicates strong-motion seismograph acceleration record.
D indicates strong-motion seismograph displacement record.
T indicates teleseismic record.
Distance is horizontal from zero.

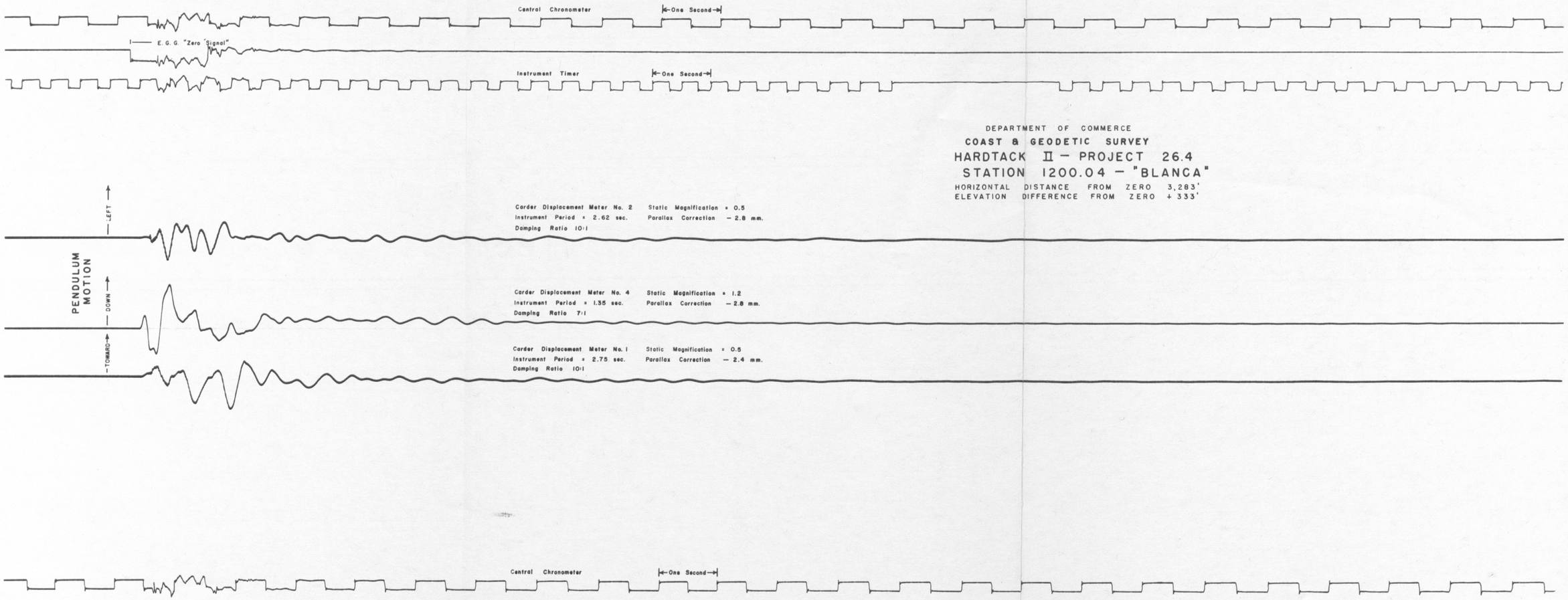

Central Chronometer
One Second
Instrument Timer
One Second
UP
AWAY
Accelerometer No. 354
Instrument Period = 0.0278 sec.
Damping Ratio 10:1
Static Magnification = 112
Sensitivity = 2.15 cm / g.
Parallax Correction + 2.2 mm.
Instrument Timer
One Second
Accelerometer No. 355
Instrument Period = 0.0280 sec.
Damping Ratio 10:1
Static Magnification = 116
Sensitivity = 2.25 cm / g.
Parallax Correction + 1.6 mm.
PENDULUM MOTION
LEFT
Accelerometer No. 356
Instrument Period = 0.0282 sec.
Damping Ratio 10:1
Static Magnification = 117
Sensitivity = 2.30 cm / g.
Parallax Correction + 1.5 mm.
Central Chronometer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.06 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 2,679'
ELEVATION DIFFERENCE FROM ZERO 00'

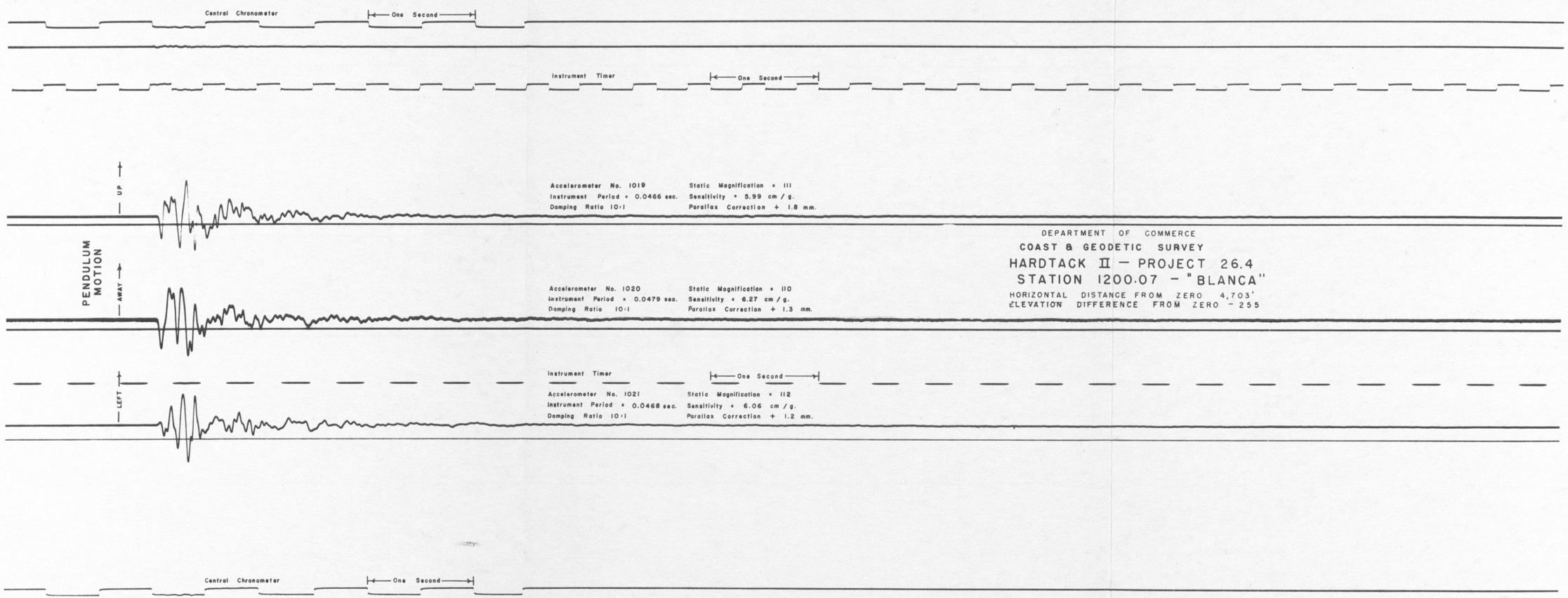


DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.06 – "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 2,679'
NO ELEVATION CORRECTION

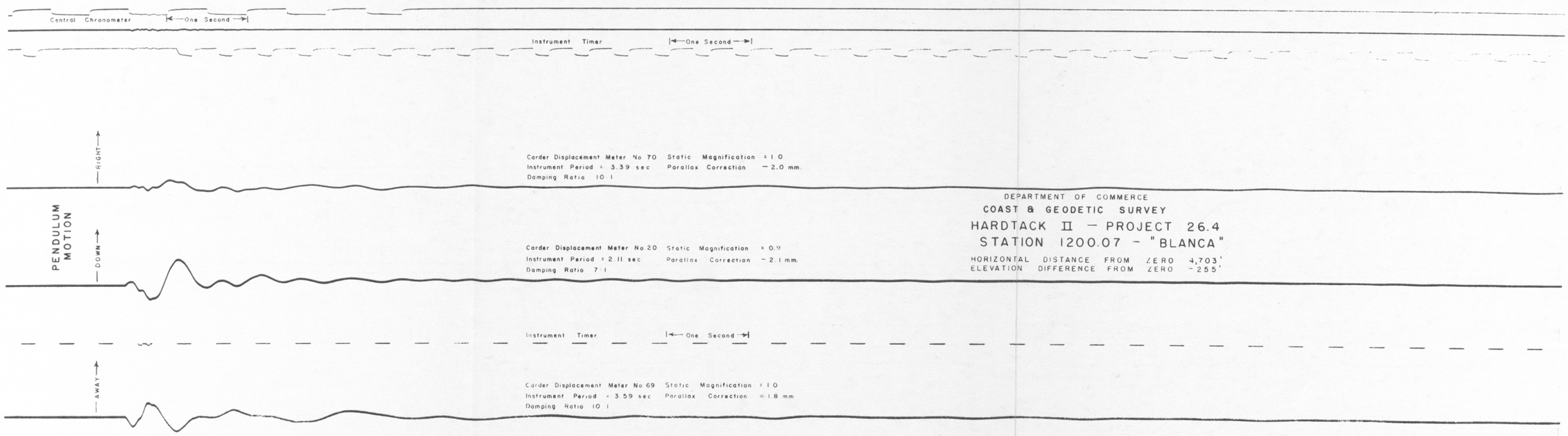


DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.04 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 3,283'
ELEVATION DIFFERENCE FROM ZERO + 333'

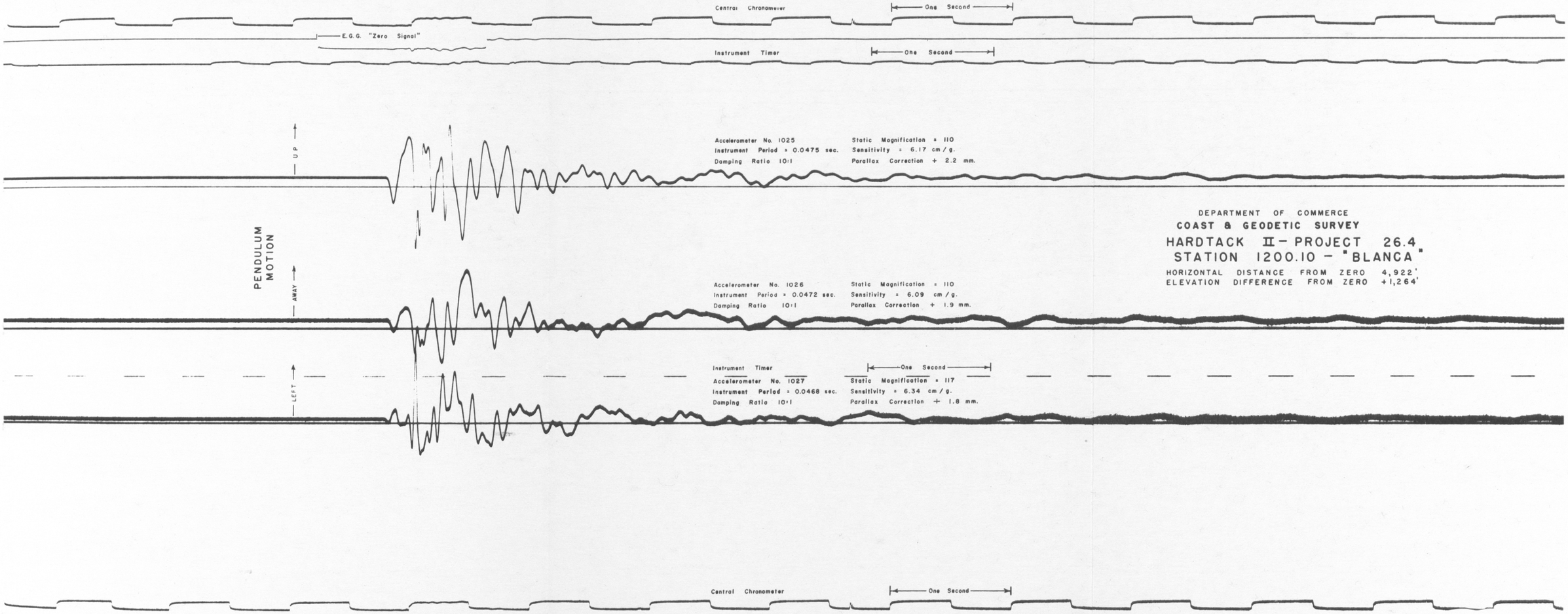

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
STATION 1200.04 — "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 3,283'
ELEVATION DIFFERENCE FROM ZERO + 333'
PENDULUM MOTION
LEFT
DOWN
TOWARD
Corder Displacement Meter No. 2 Static Magnification = 0.5
Instrument Period = 2.62 sec. Parallax Correction — 2.8 mm.
Damping Ratio 10:1
Corder Displacement Meter No. 4 Static Magnification = 1.2
Instrument Period = 1.35 sec. Parallax Correction — 2.8 mm.
Damping Ratio 7:1
Corder Displacement Meter No. 1 Static Magnification = 0.5
Instrument Period = 2.75 sec. Parallax Correction — 2.4 mm.
Damping Ratio 10:1
Central Chronometer
One Second



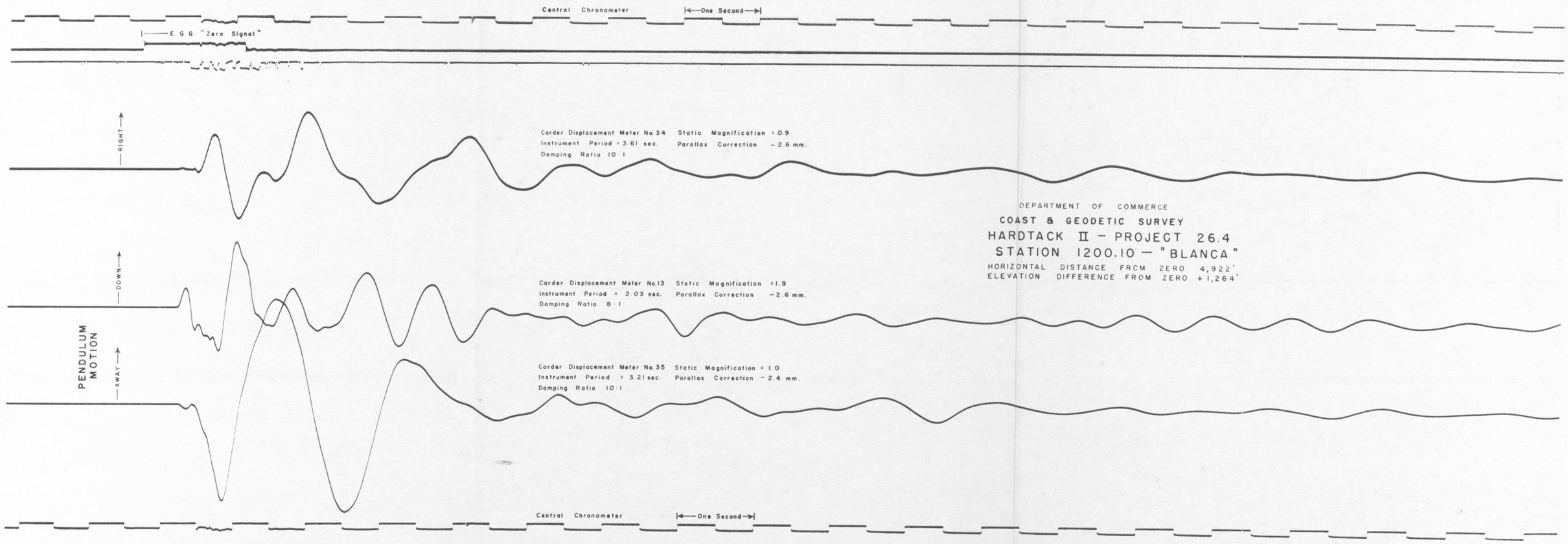
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
STATION 1200.07 — "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 4,703'
ELEVATION DIFFERENCE FROM ZERO - 255



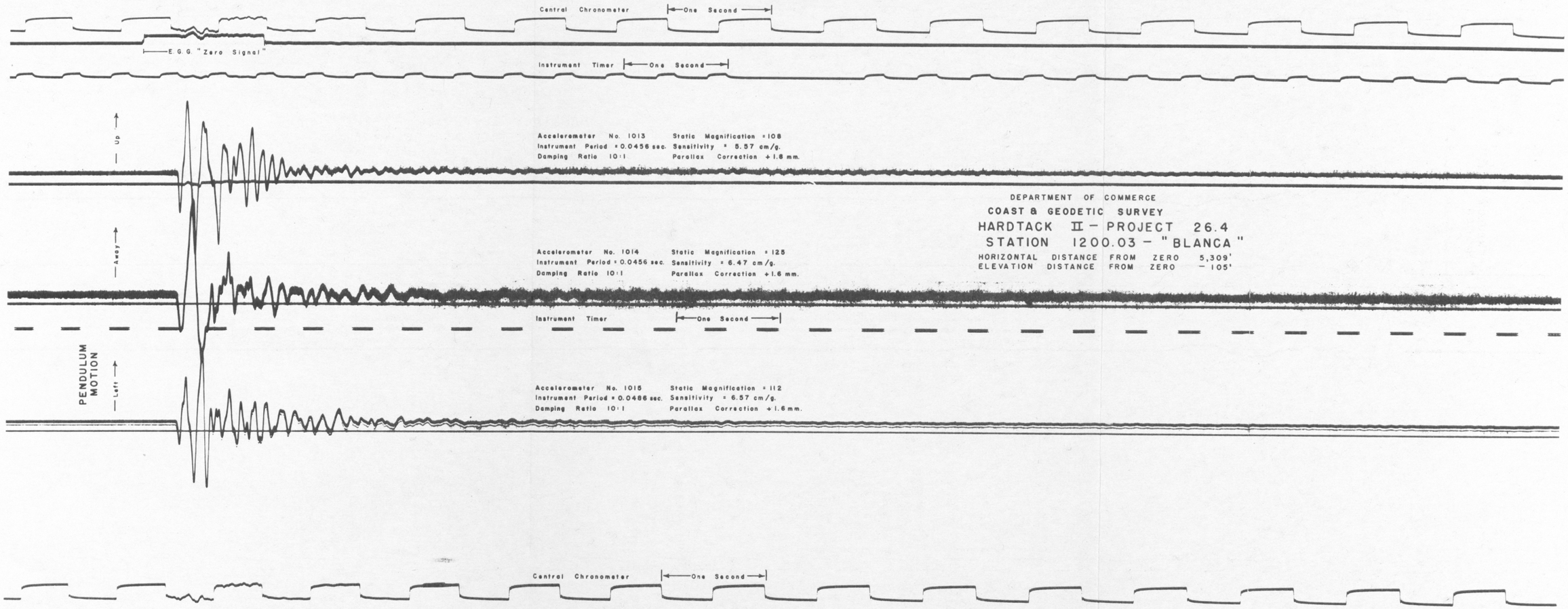
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
STATION 1200.07 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 4,703'
ELEVATION DIFFERENCE FROM ZERO -255'

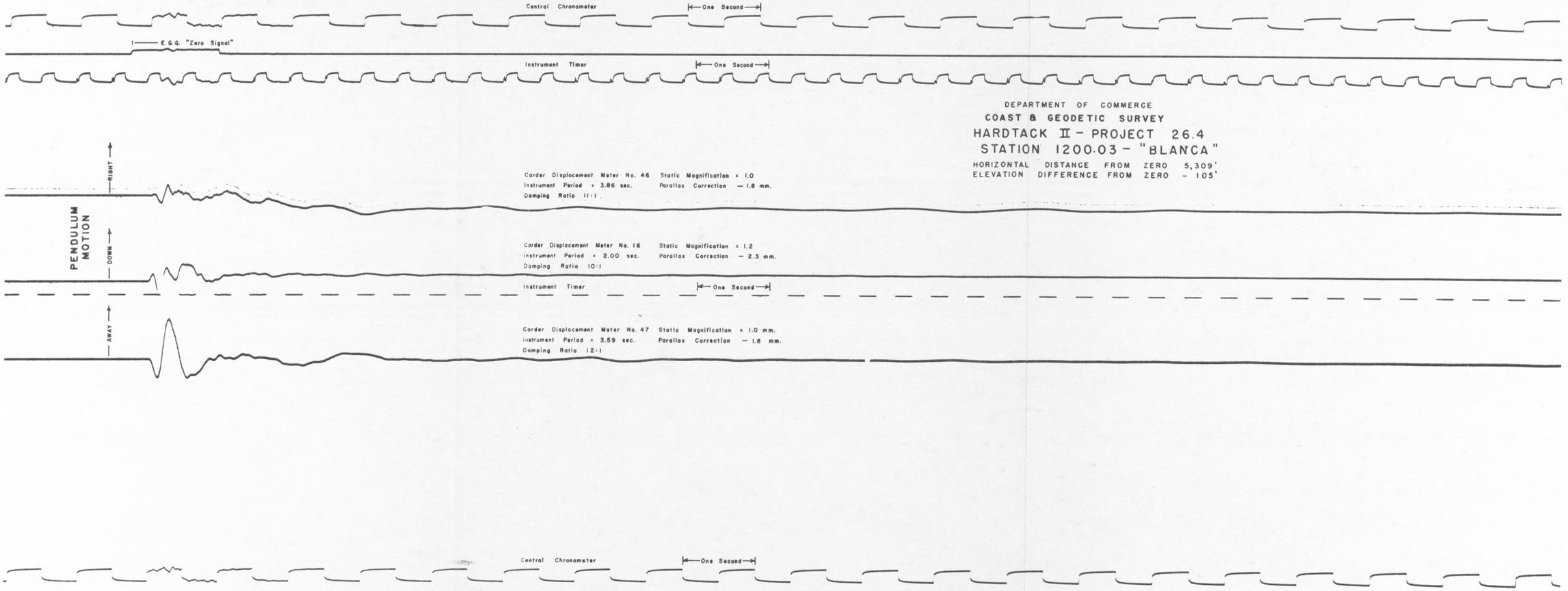


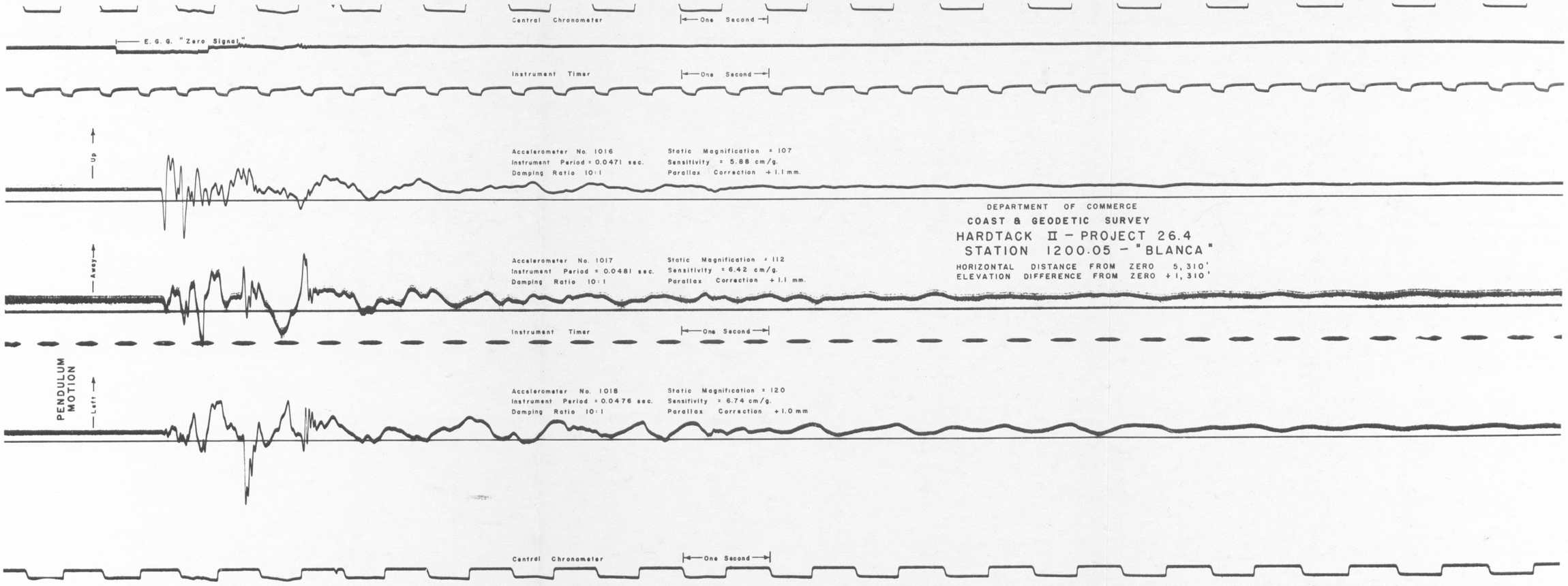
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.10 – "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 4,922'
ELEVATION DIFFERENCE FROM ZERO +1,264'

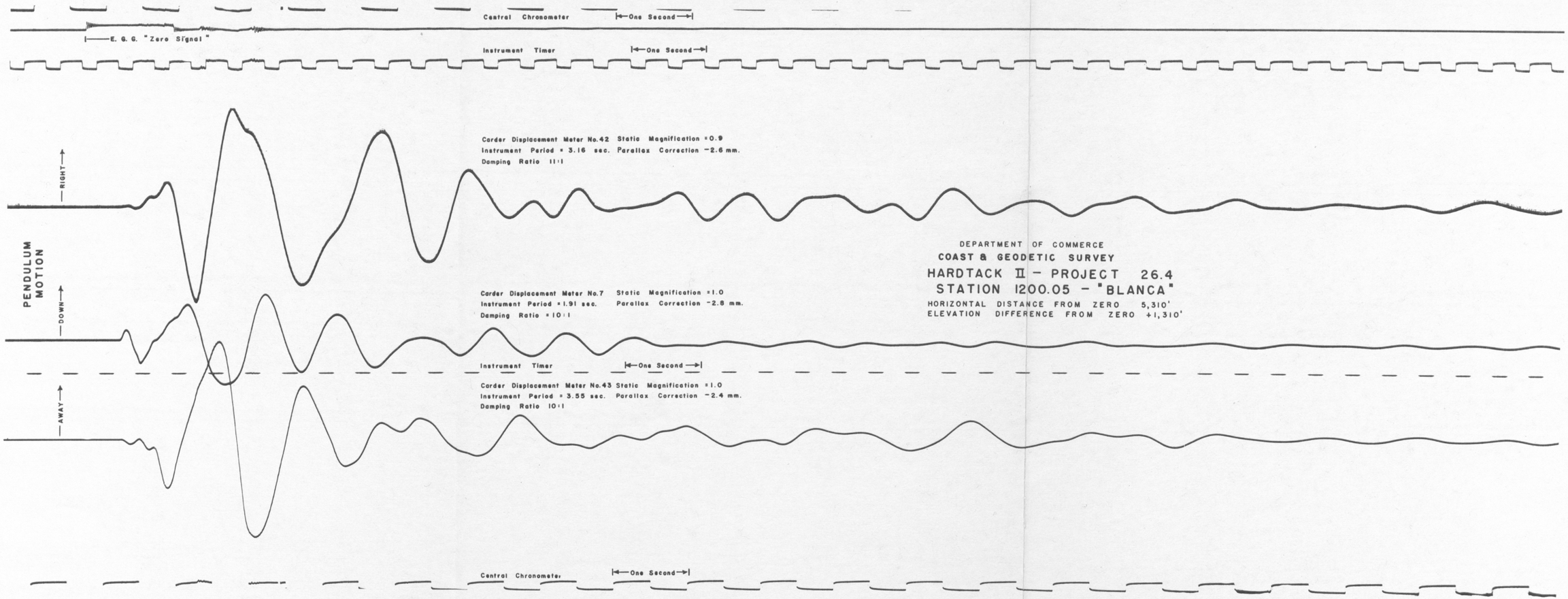


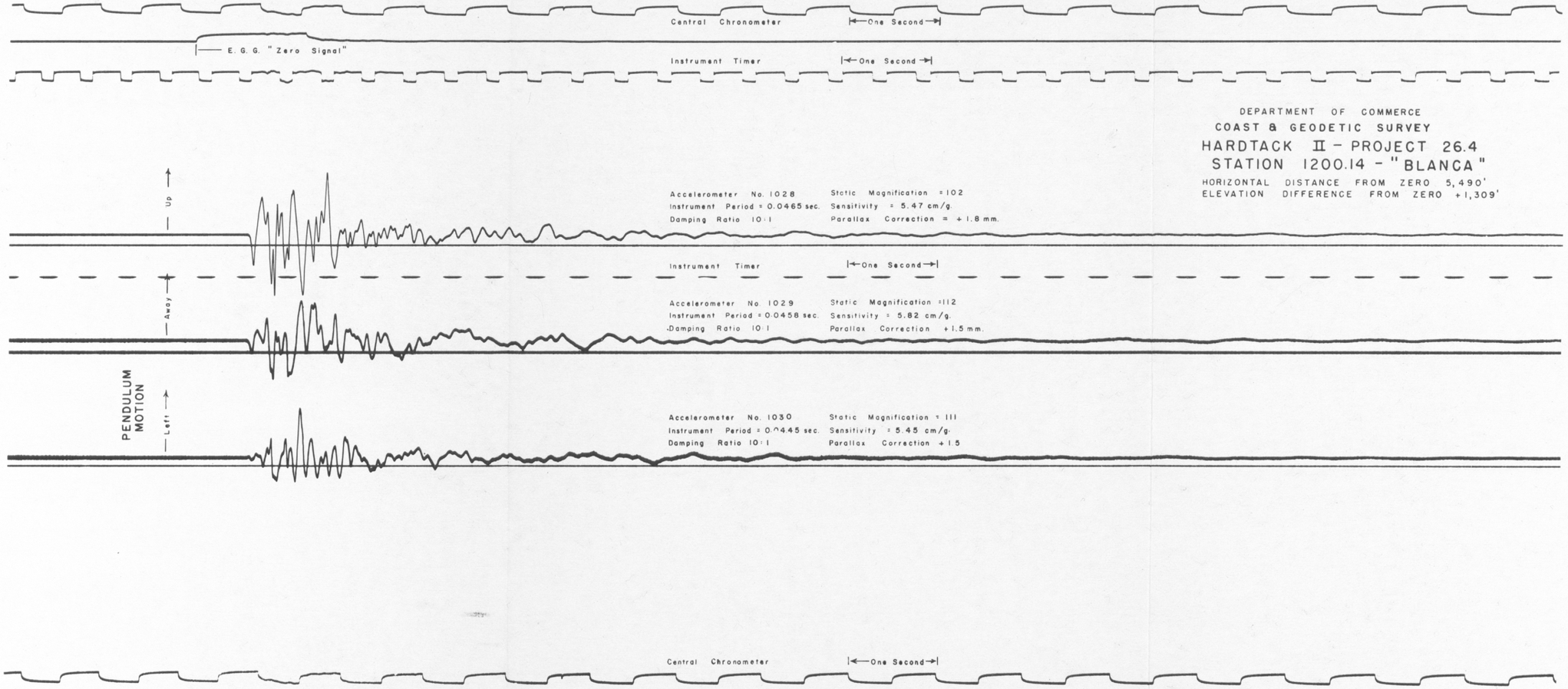
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.10 – "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 4,922'
ELEVATION DIFFERENCE FROM ZERO +1,264'

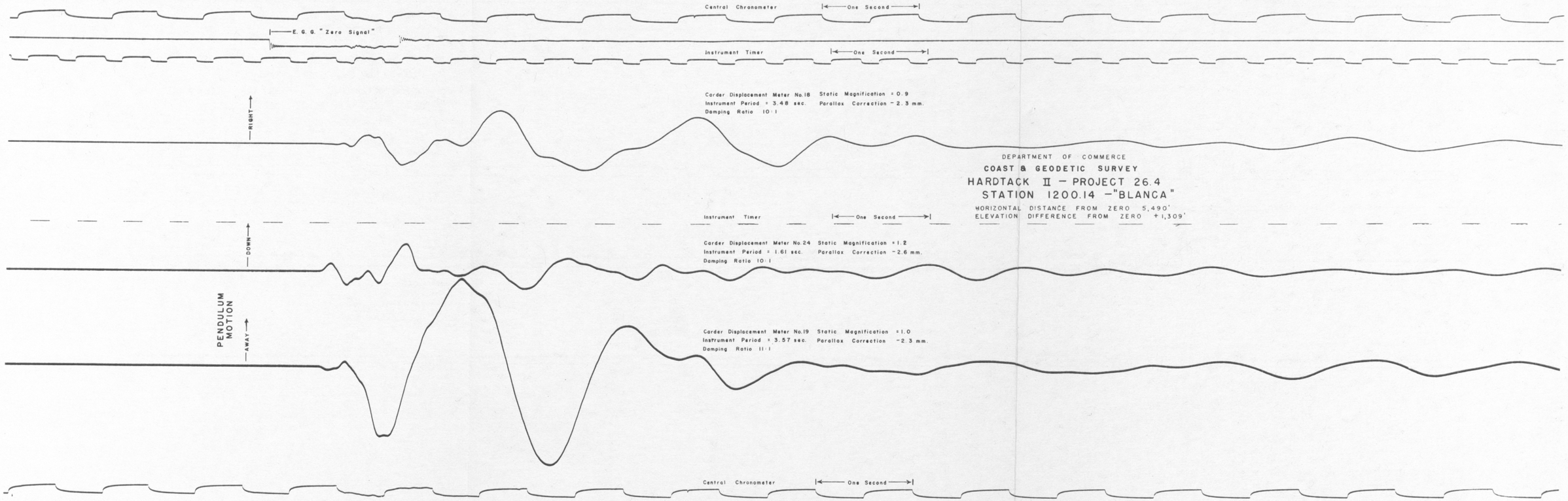

Central Chronometer
One Second
E.G.G. "Zero Signal"
Instrument Timer
One Second
Up
Away
Left
PENDULUM MOTION
Accelerometer No. 1013
Instrument Period = 0.0456 sec.
Damping Ratio 10:1
Static Magnification = 108
Sensitivity = 5.57 cm/g.
Parallax Correction +1.8 mm.
Accelerometer No. 1014
Instrument Period = 0.0456 sec.
Damping Ratio 10:1
Static Magnification = 125
Sensitivity = 6.47 cm/g.
Parallax Correction +1.8 mm.
Instrument Timer
One Second
Accelerometer No. 1015
Instrument Period = 0.0486 sec.
Damping Ratio 10:1
Static Magnification = 112
Sensitivity = 6.57 cm/g.
Parallax Correction +1.8 mm.
Central Chronometer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.03 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 5,309'
ELEVATION DISTANCE FROM ZERO - 105'

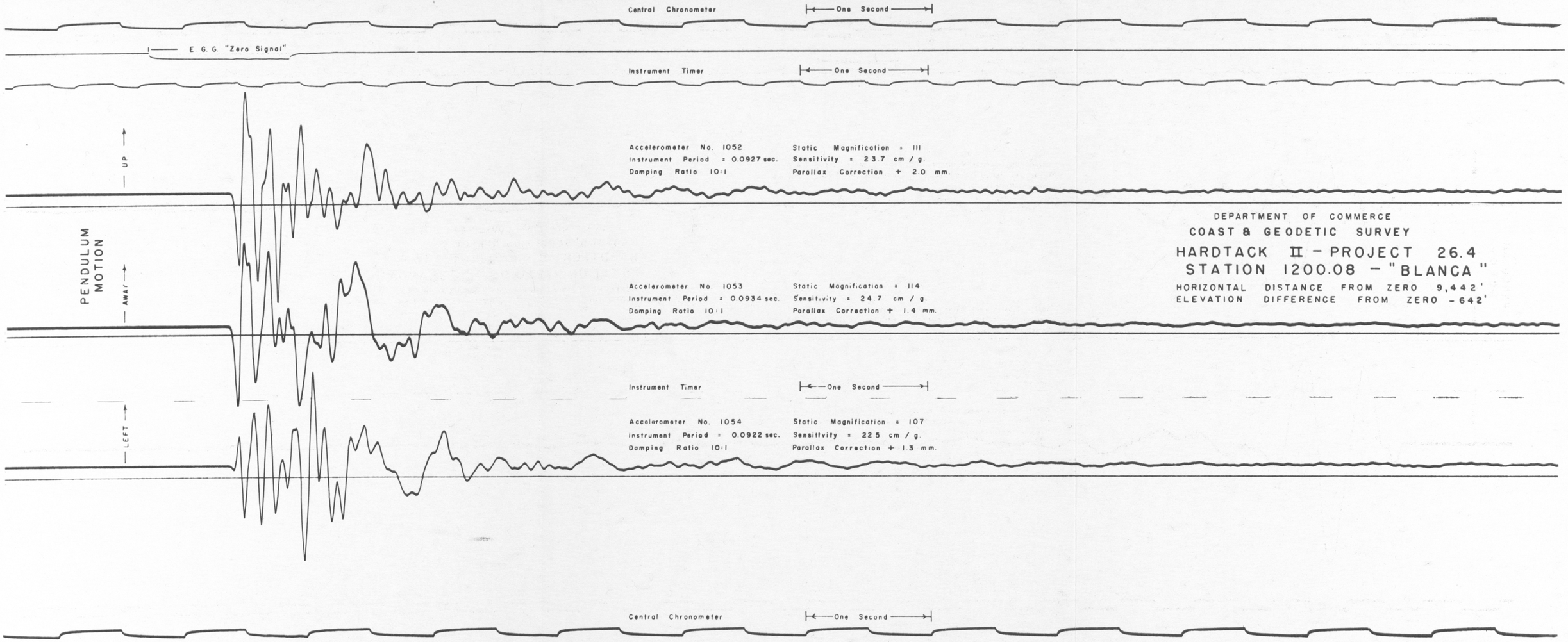

Central Chronometer
One Second
E.G.G. "Zero Signal"
Instrument Timer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.03 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 5,309'
ELEVATION DIFFERENCE FROM ZERO - 105'
RIGHT
PENDULUM MOTION
DOWN
AWAY
Corder Displacement Meter No. 46 Static Magnification = 1.0
Instrument Period = 3.86 sec. Parallax Correction — 1.8 mm.
Damping Ratio 11:1
Corder Displacement Meter No. 16 Static Magnification = 1.2
Instrument Period = 2.00 sec. Parallax Correction — 2.3 mm.
Damping Ratio 10:1
Instrument Timer
One Second
Corder Displacement Meter No. 47 Static Magnification = 1.0 mm.
Instrument Period = 3.59 sec. Parallax Correction — 1.8 mm.
Damping Ratio 12:1
Central Chronometer
One Second

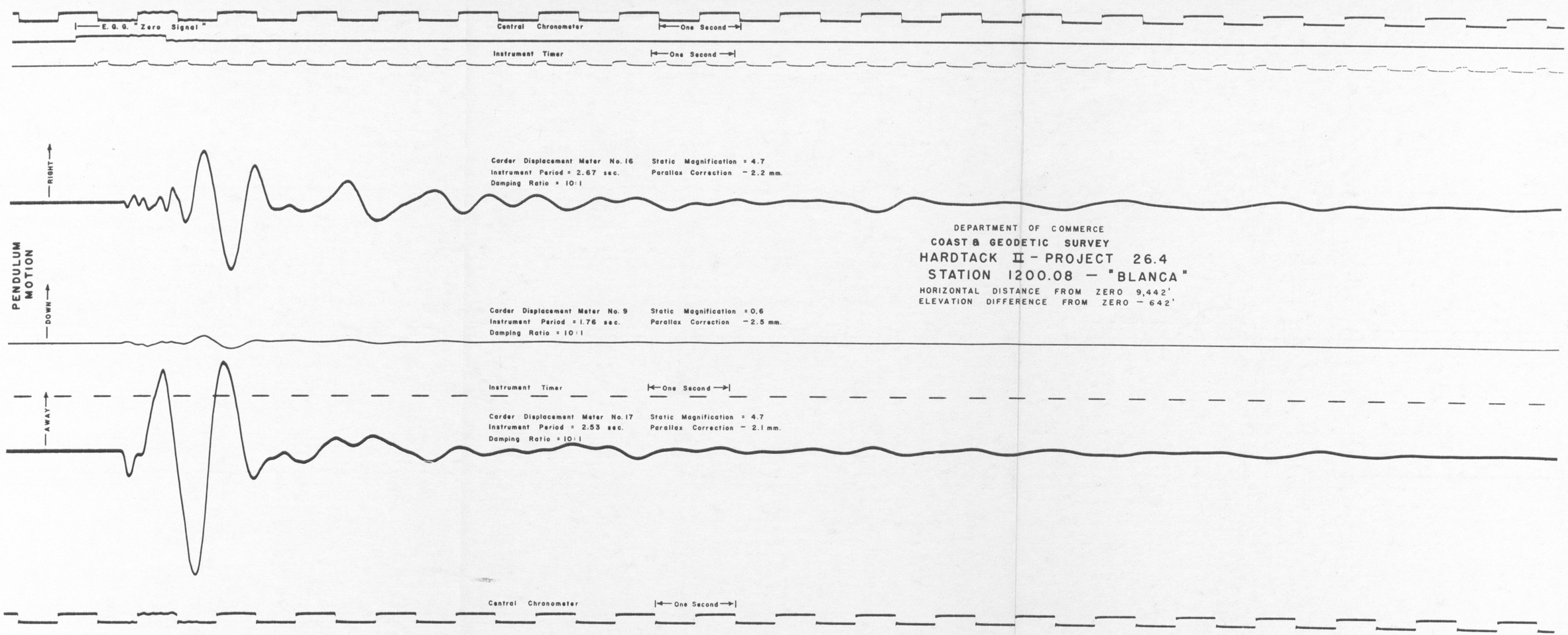

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
Up
Accelerometer No. 1016
Instrument Period = 0.0471 sec.
Damping Ratio 10:1
Static Magnification = 107
Sensitivity = 5.88 cm/g.
Parallax Correction + 1.1 mm.
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.05 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 5,310'
ELEVATION DIFFERENCE FROM ZERO + 1,310'
Away
Accelerometer No. 1017
Instrument Period = 0.0481 sec.
Damping Ratio 10:1
Static Magnification = 112
Sensitivity = 6.42 cm/g.
Parallax Correction + 1.1 mm.
Instrument Timer
One Second
PENDULUM MOTION
Left
Accelerometer No. 1018
Instrument Period = 0.0476 sec.
Damping Ratio 10:1
Static Magnification = 120
Sensitivity = 6.74 cm/g.
Parallax Correction + 1.0 mm
Central Chronometer
One Second

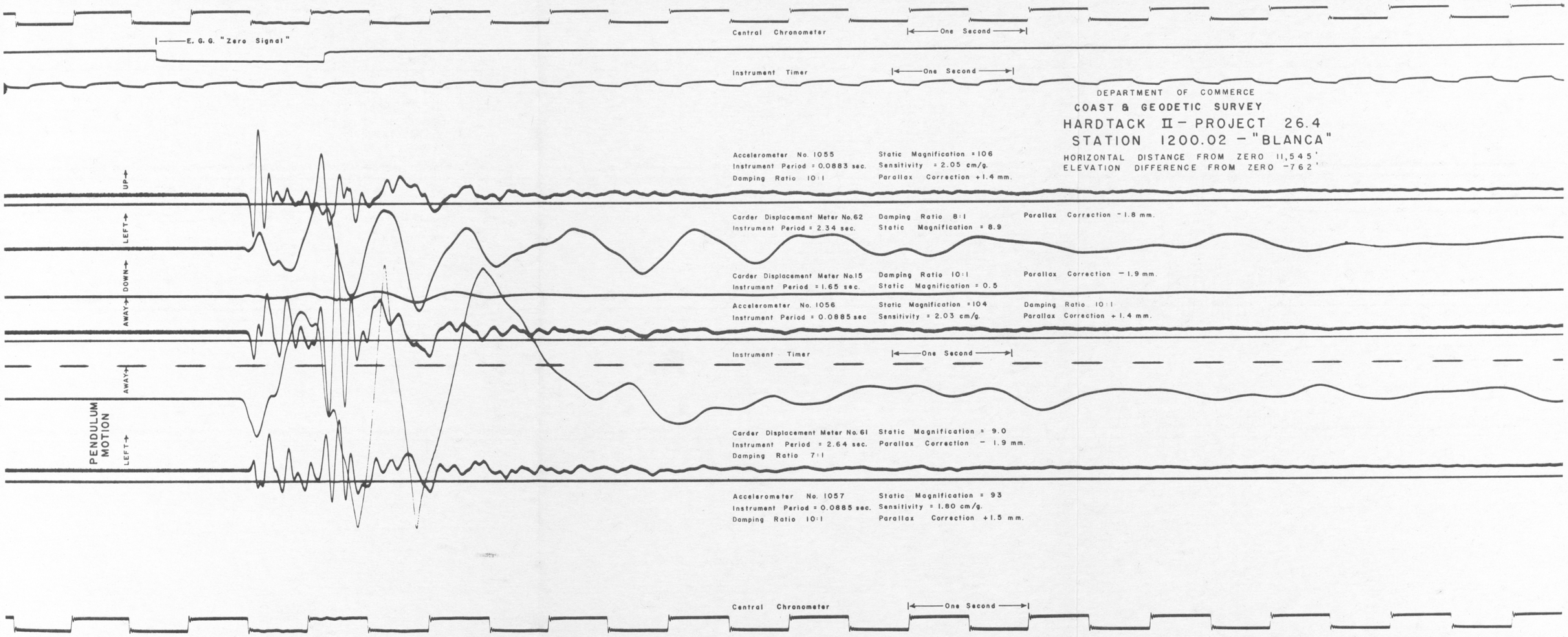

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
Corder Displacement Meter No.42 Static Magnification =0.9
Instrument Period = 3.16 sec. Parallax Correction −2.6 mm.
Damping Ratio 11:1
RIGHT
PENDULUM MOTION
DOWN
Corder Displacement Meter No.7 Static Magnification =1.0
Instrument Period =1.91 sec. Parallax Correction −2.8 mm.
Damping Ratio =10:1
Instrument Timer
One Second
Corder Displacement Meter No.43 Static Magnification =1.0
Instrument Period = 3.55 sec. Parallax Correction −2.4 mm.
Damping Ratio 10:1
AWAY
Central Chronometer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.05 – "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 5,310'
ELEVATION DIFFERENCE FROM ZERO +1,310'

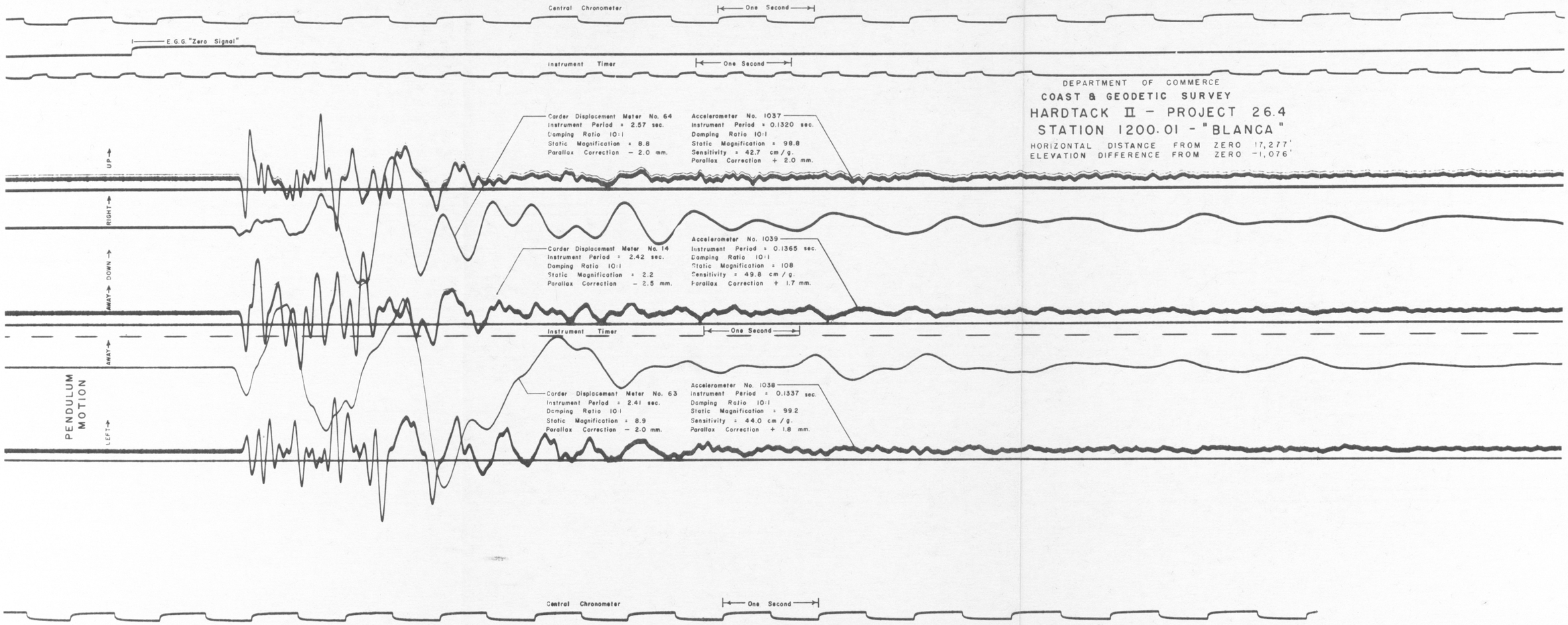

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.14 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 5,490'
ELEVATION DIFFERENCE FROM ZERO +1,309'
Up
Accelerometer No. 1028
Instrument Period = 0.0465 sec.
Damping Ratio 10:1
Static Magnification =102
Sensitivity = 5.47 cm/g.
Parallax Correction = + 1.8 mm.
Instrument Timer
One Second
Away
Accelerometer No. 1029
Instrument Period = 0.0458 sec.
Damping Ratio 10:1
Static Magnification =112
Sensitivity = 5.82 cm/g.
Parallax Correction +1.5 mm.
PENDULUM MOTION
Left
Accelerometer No. 1030
Instrument Period = 0.0445 sec.
Damping Ratio 10:1
Static Magnification = 111
Sensitivity = 5.45 cm/g.
Parallax Correction +1.5
Central Chronometer
One Second

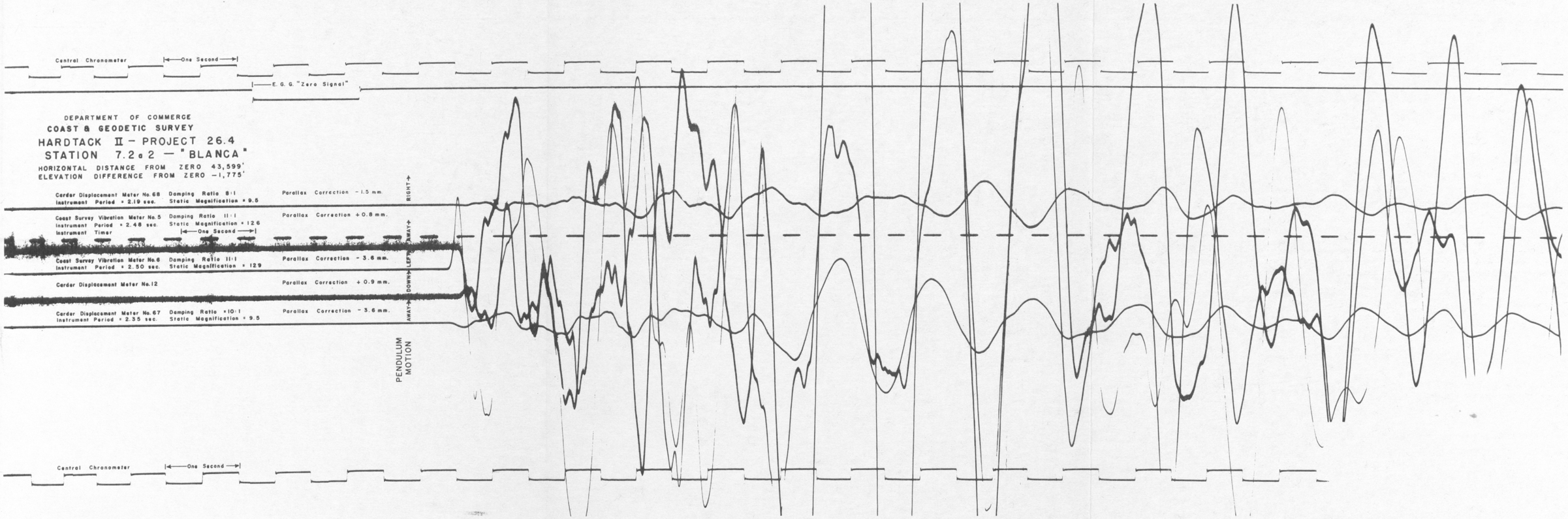

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
Corder Displacement Meter No.18 Static Magnification = 0.9
Instrument Period = 3.48 sec. Parallax Correction - 2.3 mm.
Damping Ratio 10:1
RIGHT
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.14 -"BLANCA"
HORIZONTAL DISTANCE FROM ZERO 5,490'
ELEVATION DIFFERENCE FROM ZERO +1,309'
Instrument Timer
One Second
DOWN
Corder Displacement Meter No.24 Static Magnification = 1.2
Instrument Period = 1.61 sec. Parallax Correction - 2.6 mm.
Damping Ratio 10:1
PENDULUM MOTION
AWAY
Corder Displacement Meter No.19 Static Magnification = 1.0
Instrument Period = 3.57 sec. Parallax Correction - 2.3 mm.
Damping Ratio 11:1
Central Chronometer
One Second

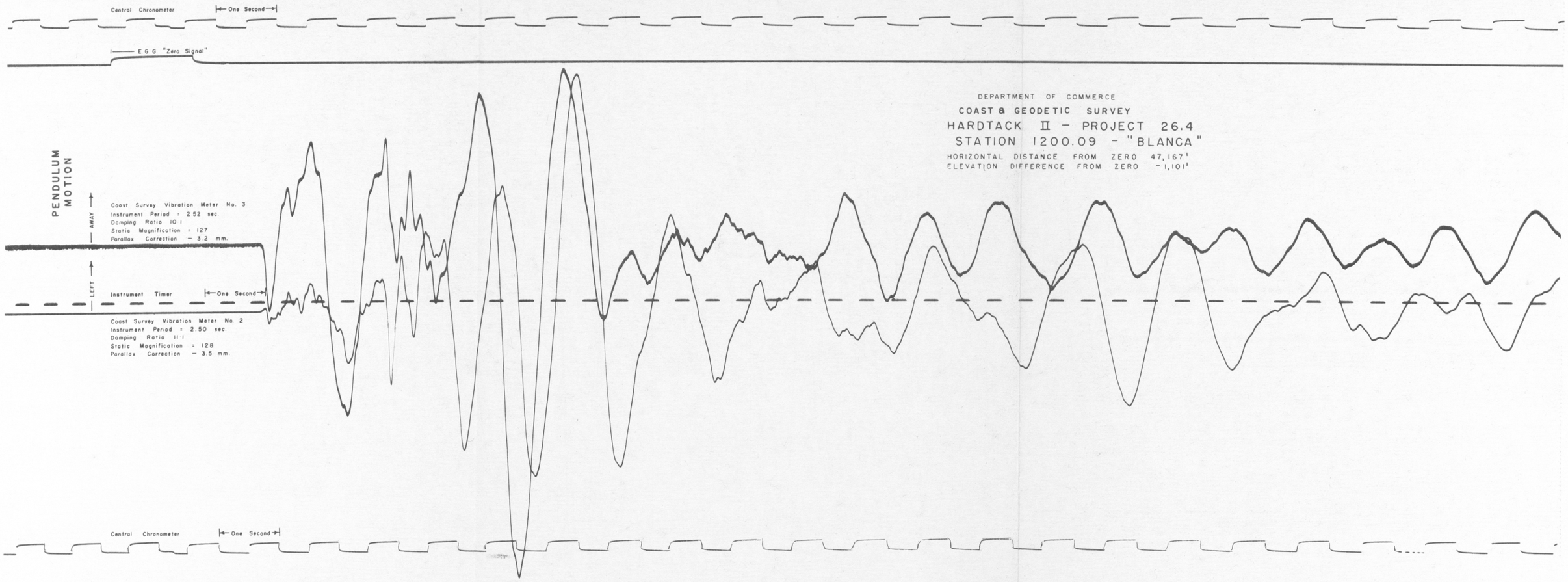

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
UP
Accelerometer No. 1052
Instrument Period = 0.0927 sec.
Damping Ratio 10:1
Static Magnification = 111
Sensitivity = 23.7 cm / g.
Parallax Correction + 2.0 mm.
PENDULUM MOTION
AWAY
Accelerometer No. 1053
Instrument Period = 0.0934 sec.
Damping Ratio 10:1
Static Magnification = 114
Sensitivity = 24.7 cm / g.
Parallax Correction + 1.4 mm.
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.08 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 9,442'
ELEVATION DIFFERENCE FROM ZERO -642'
Instrument Timer
One Second
LEFT
Accelerometer No. 1054
Instrument Period = 0.0922 sec.
Damping Ratio 10:1
Static Magnification = 107
Sensitivity = 22.5 cm / g.
Parallax Correction + 1.3 mm.
Central Chronometer
One Second

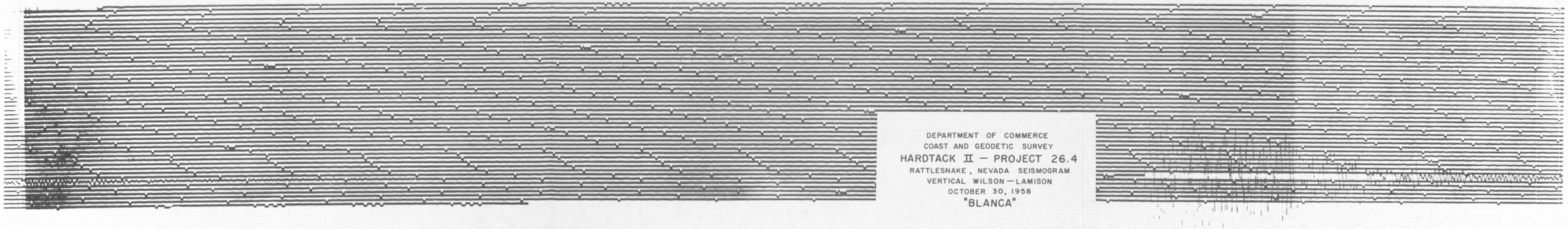

E. G. G. "Zero Signal"
Central Chronometer
One Second
Instrument Timer
One Second
RIGHT
Carder Displacement Meter No. 16
Instrument Period = 2.67 sec.
Damping Ratio = 10:1
Static Magnification = 4.7
Parallax Correction − 2.2 mm.
PENDULUM MOTION
DOWN
Carder Displacement Meter No. 9
Instrument Period = 1.76 sec.
Damping Ratio = 10:1
Static Magnification = 0.6
Parallax Correction − 2.5 mm.
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.08 — "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 9,442'
ELEVATION DIFFERENCE FROM ZERO − 642'
Instrument Timer
One Second
AWAY
Carder Displacement Meter No. 17
Instrument Period = 2.53 sec.
Damping Ratio = 10:1
Static Magnification = 4.7
Parallax Correction − 2.1 mm.
Central Chronometer
One Second


E. G. G. "Zero Signal"
Central Chronometer
One Second
Instrument Timer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.02 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 11,545'
ELEVATION DIFFERENCE FROM ZERO -762'
Accelerometer No. 1055
Instrument Period = 0.0883 sec.
Damping Ratio 10:1
Static Magnification =106
Sensitivity = 2.05 cm/g.
Parallax Correction +1.4 mm.
UP
Carder Displacement Meter No.62
Instrument Period = 2.34 sec.
Damping Ratio 8:1
Static Magnification = 8.9
Parallax Correction -1.8 mm.
LEFT
DOWN
Carder Displacement Meter No.15
Instrument Period =1.65 sec.
Damping Ratio 10:1
Static Magnification = 0.5
Parallax Correction -1.9 mm.
AWAY
Accelerometer No. 1056
Instrument Period = 0.0885 sec
Static Magnification =104
Sensitivity = 2.03 cm/g.
Damping Ratio 10:1
Parallax Correction +1.4 mm.
Instrument Timer
One Second
AWAY
PENDULUM MOTION
LEFT
Carder Displacement Meter No. 61
Instrument Period = 2.64 sec.
Damping Ratio 7:1
Static Magnification = 9.0
Parallax Correction - 1.9 mm.
Accelerometer No. 1057
Instrument Period = 0.0885 sec.
Damping Ratio 10:1
Static Magnification = 93
Sensitivity = 1.80 cm/g.
Parallax Correction +1.5 mm.
Central Chronometer
One Second

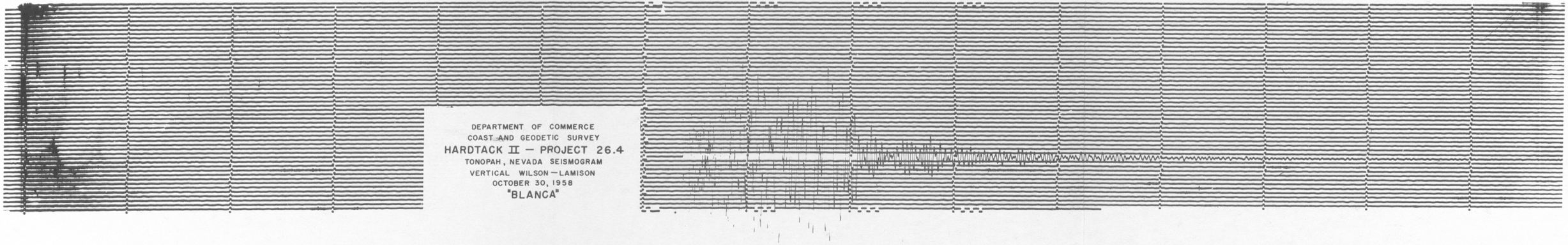

Central Chronometer
One Second
E.G.G. "Zero Signal"
Instrument Timer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.01 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 17,277'
ELEVATION DIFFERENCE FROM ZERO -1,076'
Corder Displacement Meter No. 64
Instrument Period = 2.57 sec.
Damping Ratio 10:1
Static Magnification = 8.8
Parallax Correction - 2.0 mm.
Accelerometer No. 1037
Instrument Period = 0.1320 sec.
Damping Ratio 10:1
Static Magnification = 98.8
Sensitivity = 42.7 cm/g.
Parallax Correction + 2.0 mm.
UP
RIGHT
Corder Displacement Meter No. 14
Instrument Period = 2.42 sec.
Damping Ratio 10:1
Static Magnification = 2.2
Parallax Correction - 2.5 mm.
Accelerometer No. 1039
Instrument Period = 0.1365 sec.
Damping Ratio 10:1
Static Magnification = 108
Sensitivity = 49.8 cm/g.
Parallax Correction + 1.7 mm.
AWAY
DOWN
Instrument Timer
One Second
AWAY
PENDULUM MOTION
Corder Displacement Meter No. 63
Instrument Period = 2.41 sec.
Damping Ratio 10:1
Static Magnification = 8.9
Parallax Correction - 2.0 mm.
Accelerometer No. 1038
Instrument Period = 0.1337 sec.
Damping Ratio 10:1
Static Magnification = 99.2
Sensitivity = 44.0 cm/g.
Parallax Correction + 1.8 mm.
LEFT
Central Chronometer
One Second


Central Chronometer
One Second
E. G. G. "Zero Signal"
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 7.2 a 2 — "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 43,599'
ELEVATION DIFFERENCE FROM ZERO -1,775'
Carder Displacement Meter No. 68 Damping Ratio 8:1 Parallax Correction -1.5 mm.
Instrument Period = 2.19 sec. Static Magnification = 9.5
Coast Survey Vibration Meter No. 5 Damping Ratio 11:1 Parallax Correction +0.8 mm.
Instrument Period = 2.48 sec. Static Magnification = 126
Instrument Timer
One Second
Coast Survey Vibration Meter No. 6 Damping Ratio 11:1 Parallax Correction -3.6 mm.
Instrument Period = 2.50 sec. Static Magnification = 129
Carder Displacement Meter No. 12 Parallax Correction +0.9 mm.
Carder Displacement Meter No. 67 Damping Ratio =10:1 Parallax Correction -3.6 mm.
Instrument Period = 2.35 sec. Static Magnification = 9.5
PENDULUM MOTION
RIGHT+
AWAY+
DOWN+
LEFT+
AWAY+
Central Chronometer
One Second

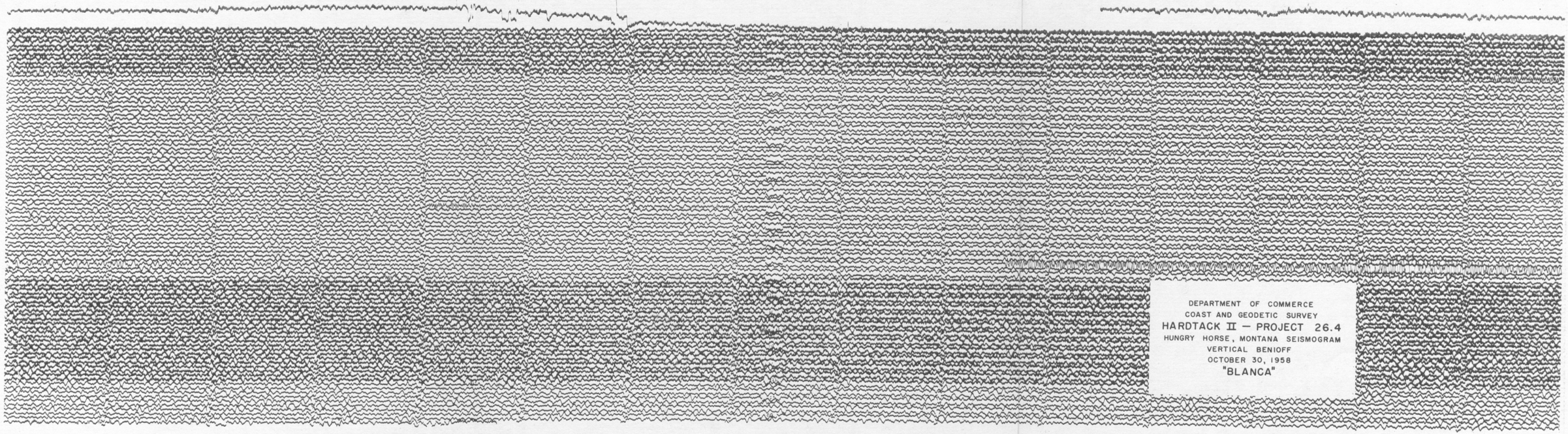

Central Chronometer
One Second
E.G.G. "Zero Signal"
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.09 - "BLANCA"
HORIZONTAL DISTANCE FROM ZERO 47,167'
ELEVATION DIFFERENCE FROM ZERO -1,101'
PENDULUM MOTION
AWAY
LEFT
Coast Survey Vibration Meter No. 3
Instrument Period = 2.52 sec.
Damping Ratio 10:1
Static Magnification = 127
Parallax Correction - 3.2 mm.
Instrument Timer
One Second
Coast Survey Vibration Meter No. 2
Instrument Period = 2.50 sec.
Damping Ratio 11:1
Static Magnification = 128
Parallax Correction - 3.5 mm.
Central Chronometer
One Second

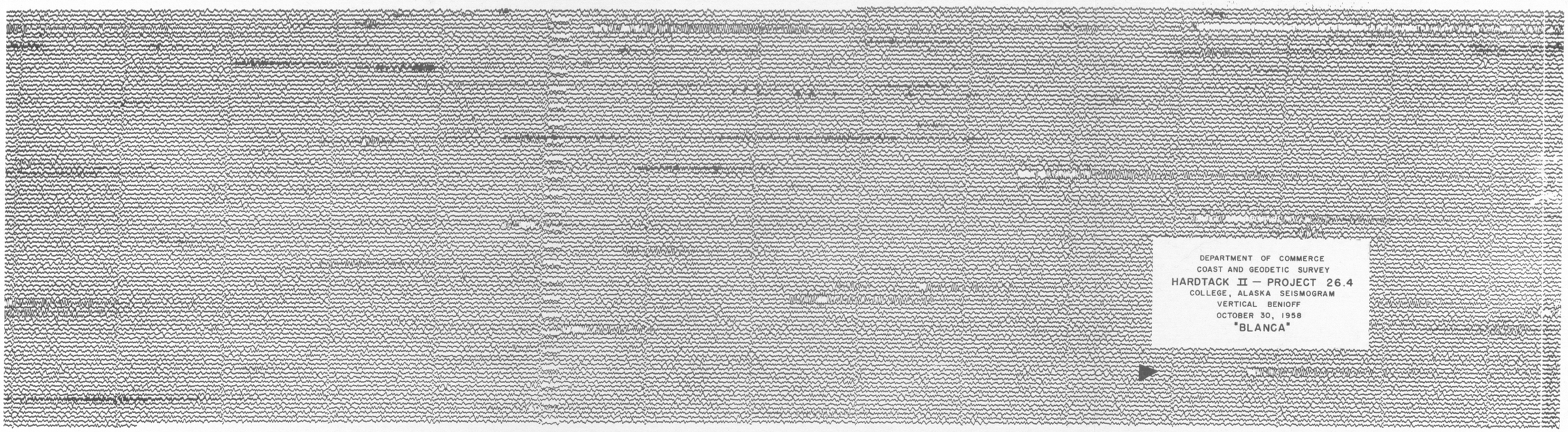


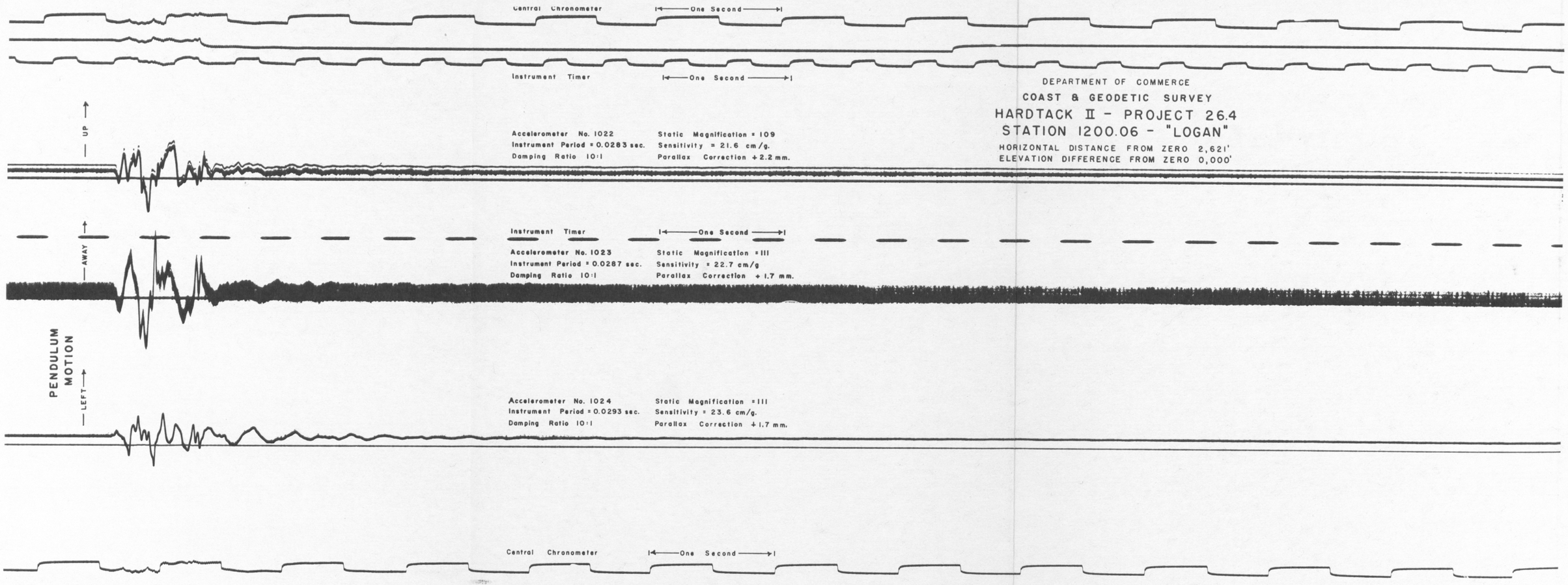
DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
RATTLESNAKE, NEVADA SEISMOGRAM
VERTICAL WILSON—LAMISON
OCTOBER 30, 1958
"BLANCA"



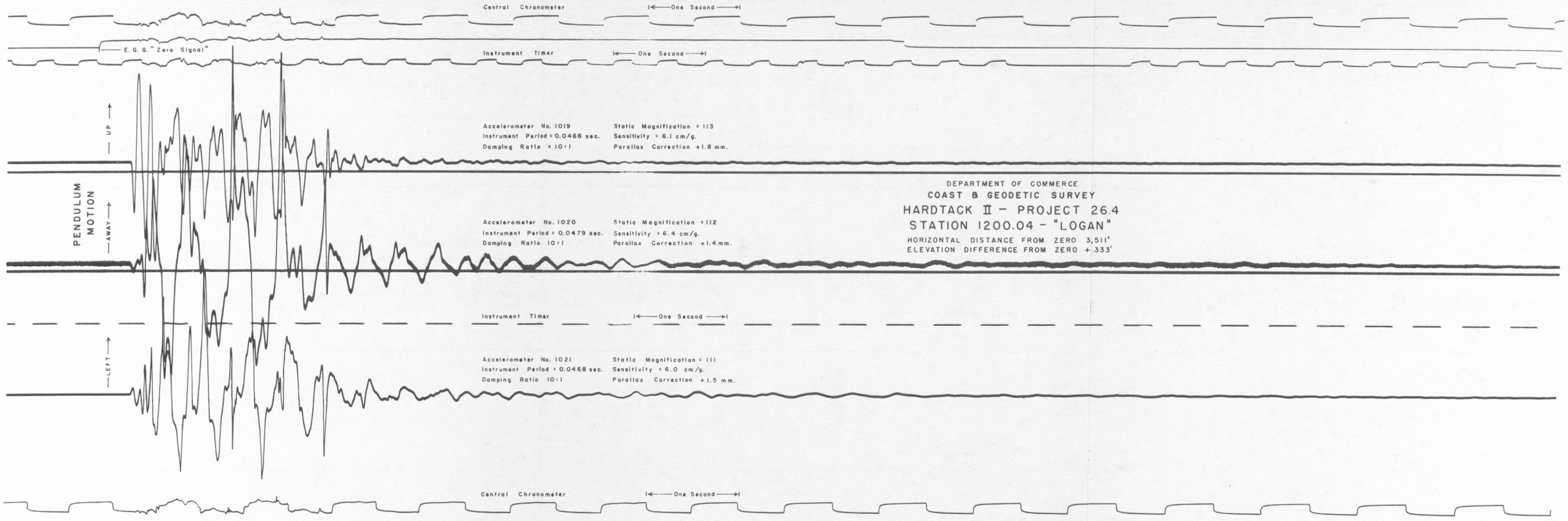
DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
TONOPAH, NEVADA SEISMOGRAM
VERTICAL WILSON—LAMISON
OCTOBER 30, 1958
"BLANCA"

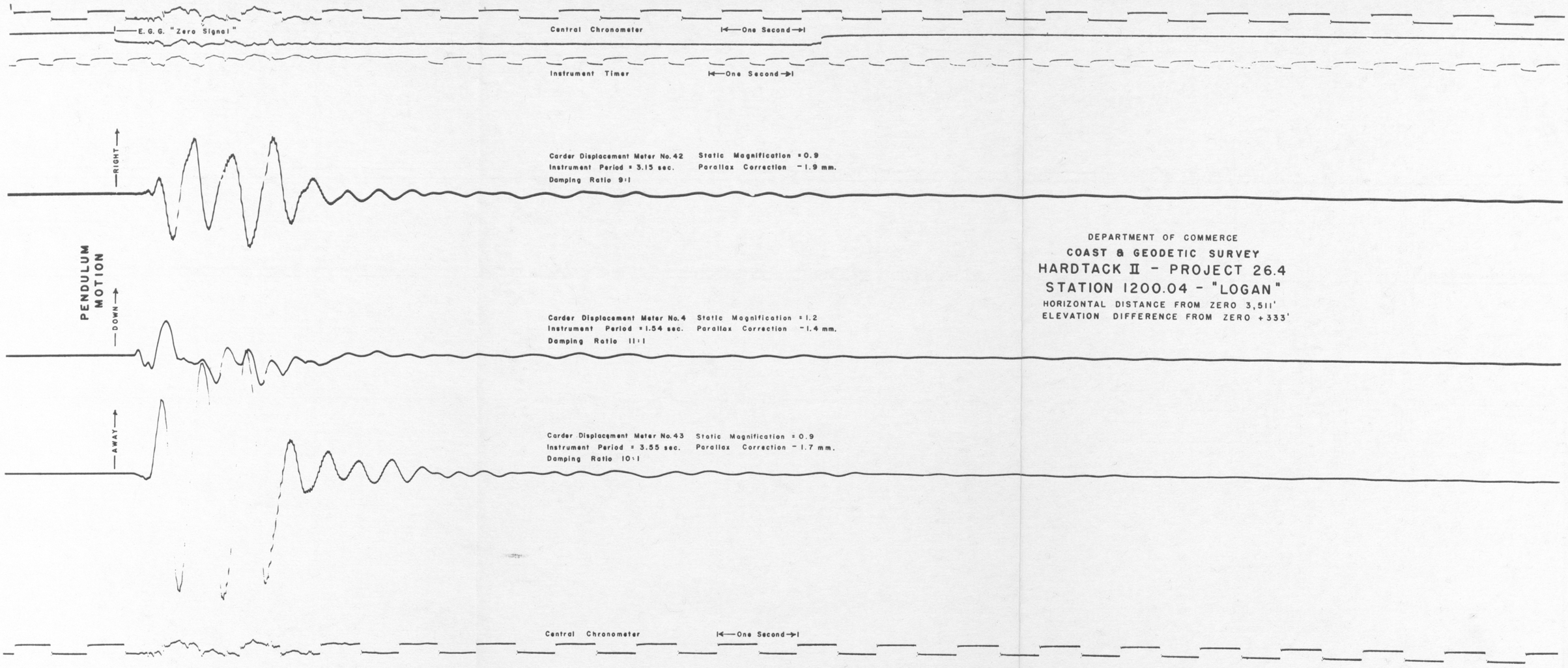

DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
HUNGRY HORSE, MONTANA SEISMOGRAM
VERTICAL BENIOFF
OCTOBER 30, 1958
"BLANCA"


DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
COLLEGE, ALASKA SEISMOGRAM
VERTICAL BENIOFF
OCTOBER 30, 1958
"BLANCA"

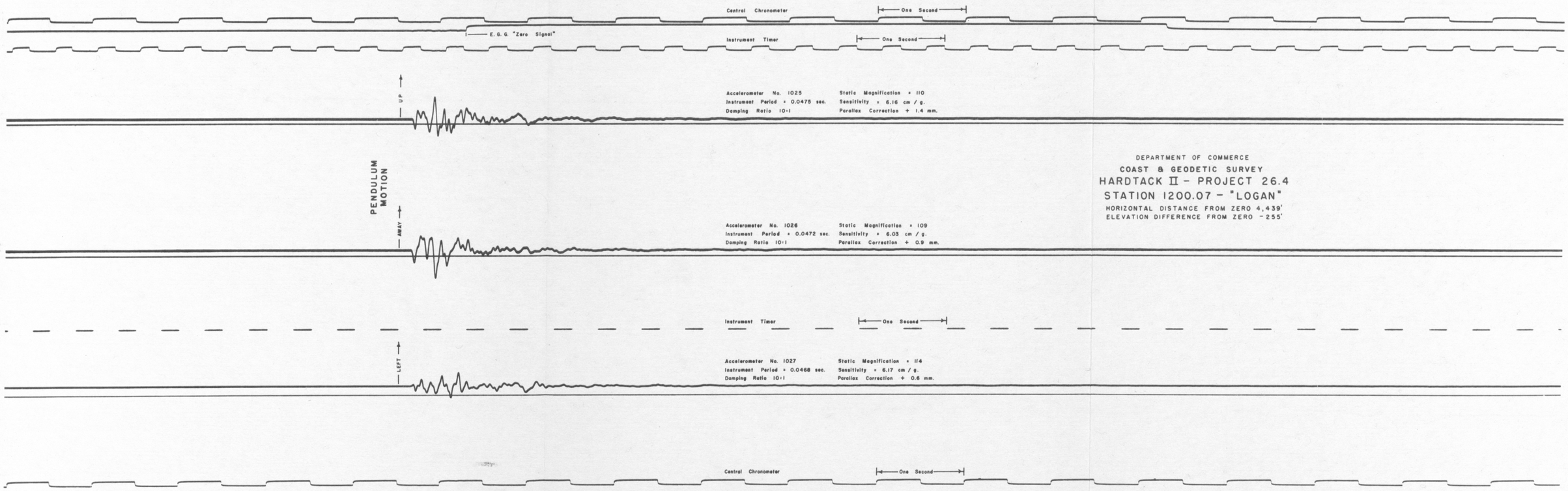


DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.06 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 2,621'
ELEVATION DIFFERENCE FROM ZERO 0,000'

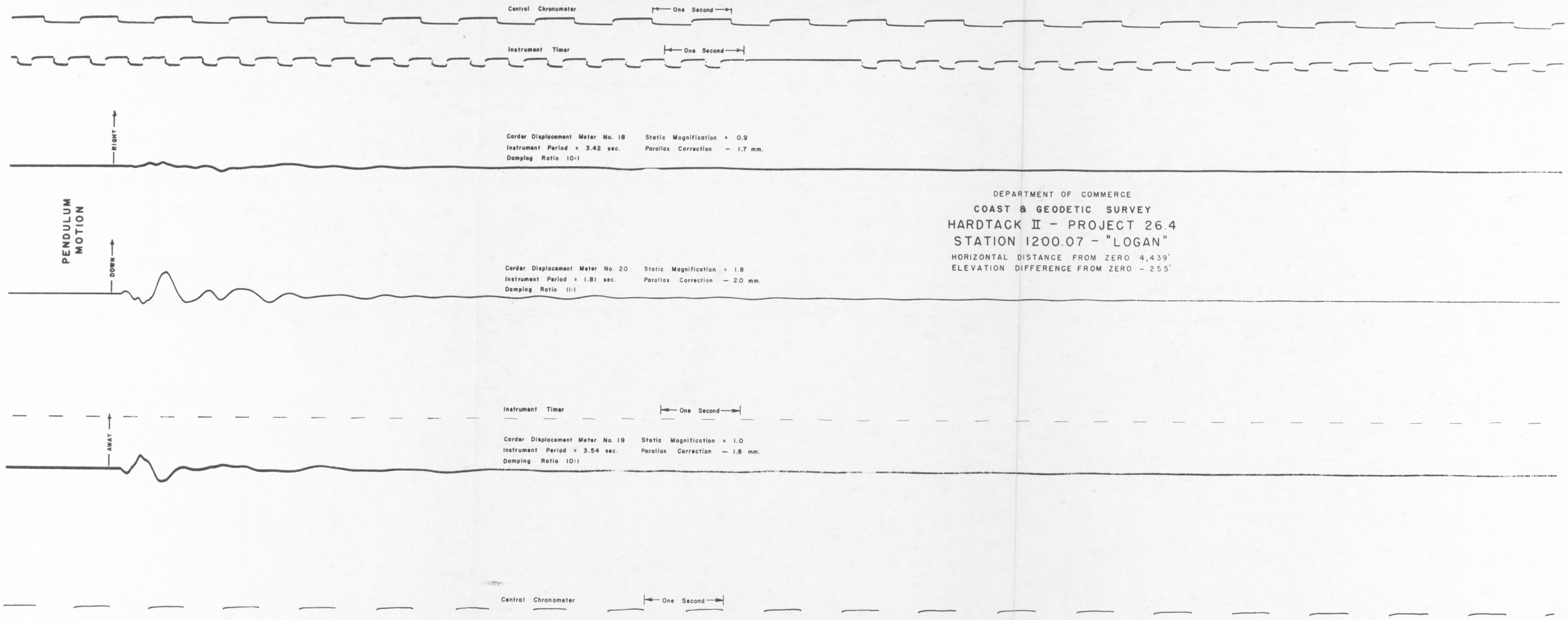

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
UP
Accelerometer No. 1019
Instrument Period = 0.0466 sec.
Damping Ratio = 10:1
Static Magnification = 113
Sensitivity = 6.1 cm/g.
Parallax Correction +1.8 mm.
PENDULUM MOTION
AWAY
Accelerometer No. 1020
Instrument Period = 0.0479 sec.
Damping Ratio 10:1
Static Magnification = 112
Sensitivity = 6.4 cm/g.
Parallax Correction +1.4 mm.
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.04 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 3,511'
ELEVATION DIFFERENCE FROM ZERO +333'
Instrument Timer
One Second
LEFT
Accelerometer No. 1021
Instrument Period = 0.0468 sec.
Damping Ratio 10:1
Static Magnification = 111
Sensitivity = 6.0 cm/g.
Parallax Correction +1.5 mm.
Central Chronometer
One Second



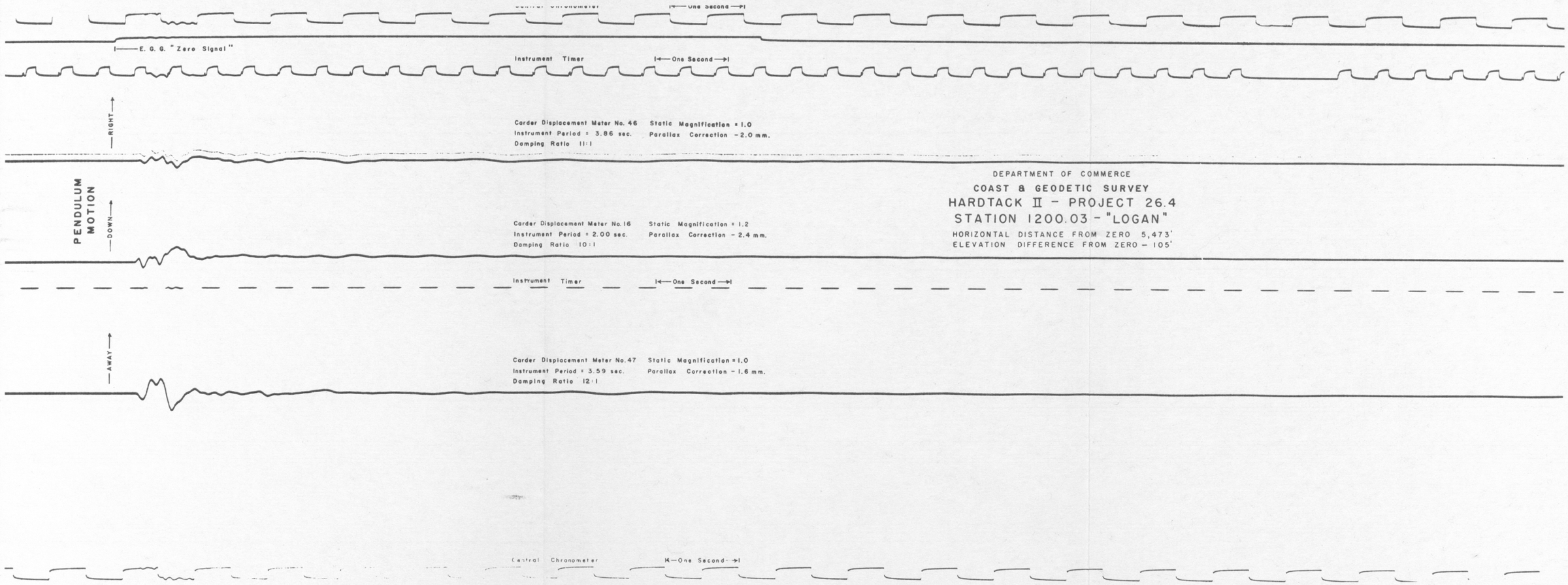
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.04 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 3,511'
ELEVATION DIFFERENCE FROM ZERO +333'



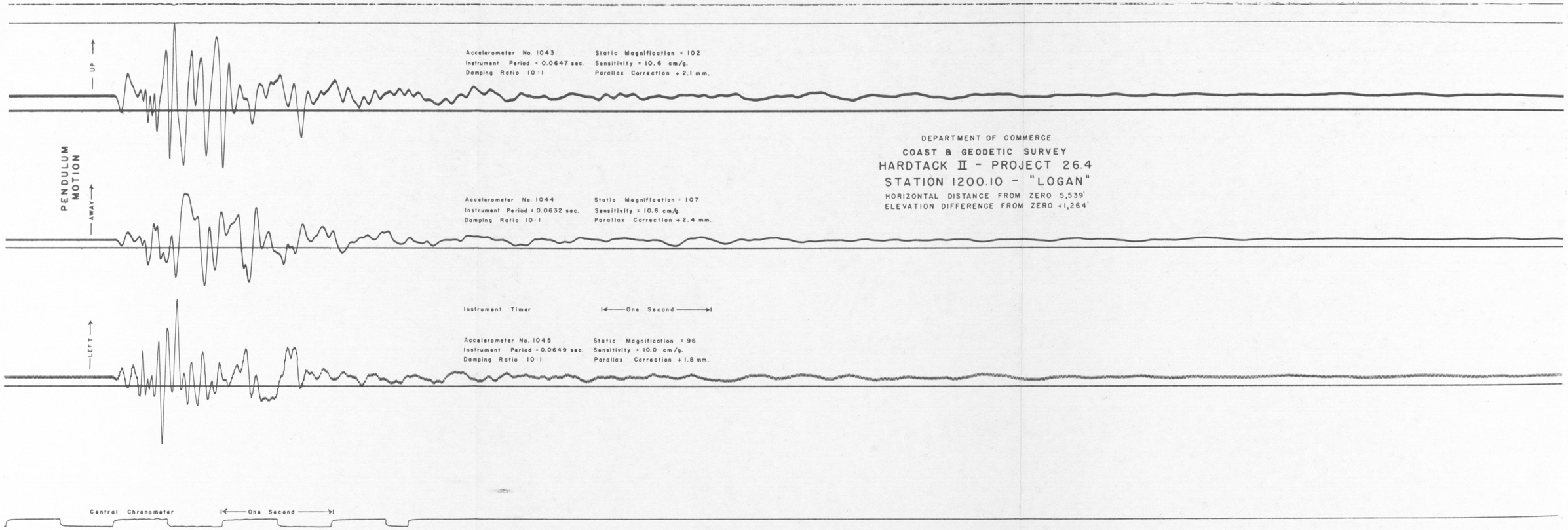
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.07 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 4,439'
ELEVATION DIFFERENCE FROM ZERO -255'



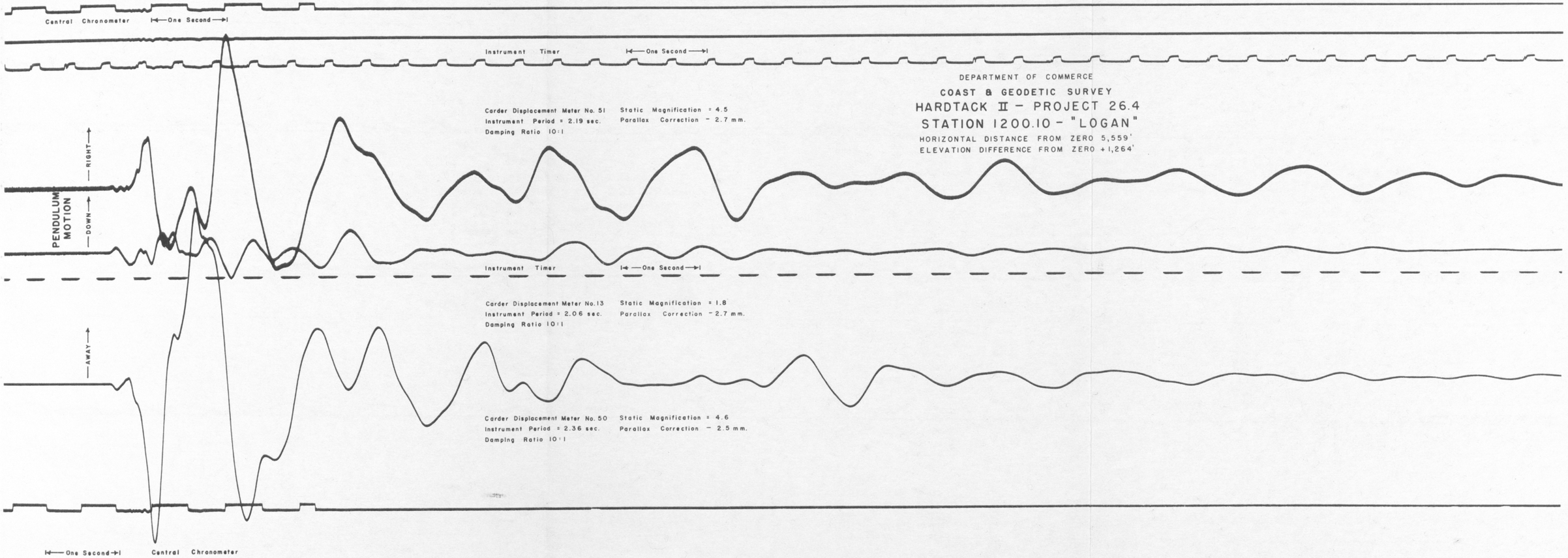
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.07 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 4,439'
ELEVATION DIFFERENCE FROM ZERO - 255'

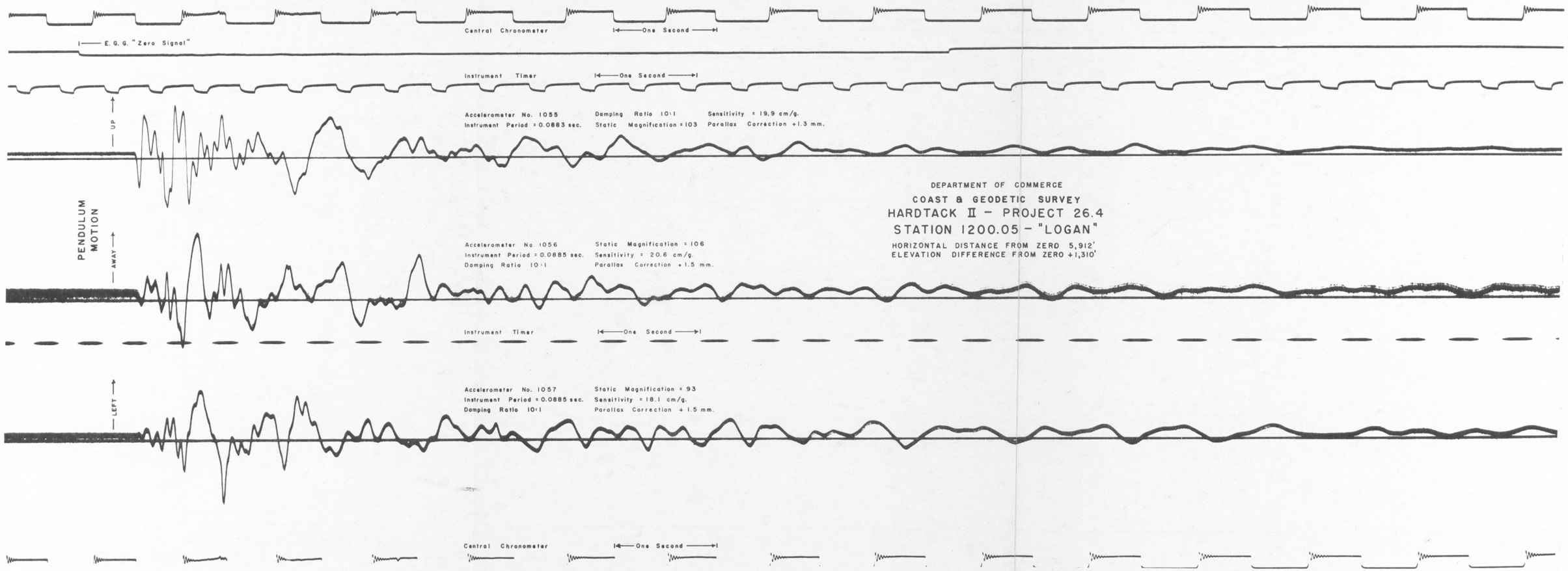


DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.03 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 5,473'
ELEVATION DIFFERENCE FROM ZERO - 105'

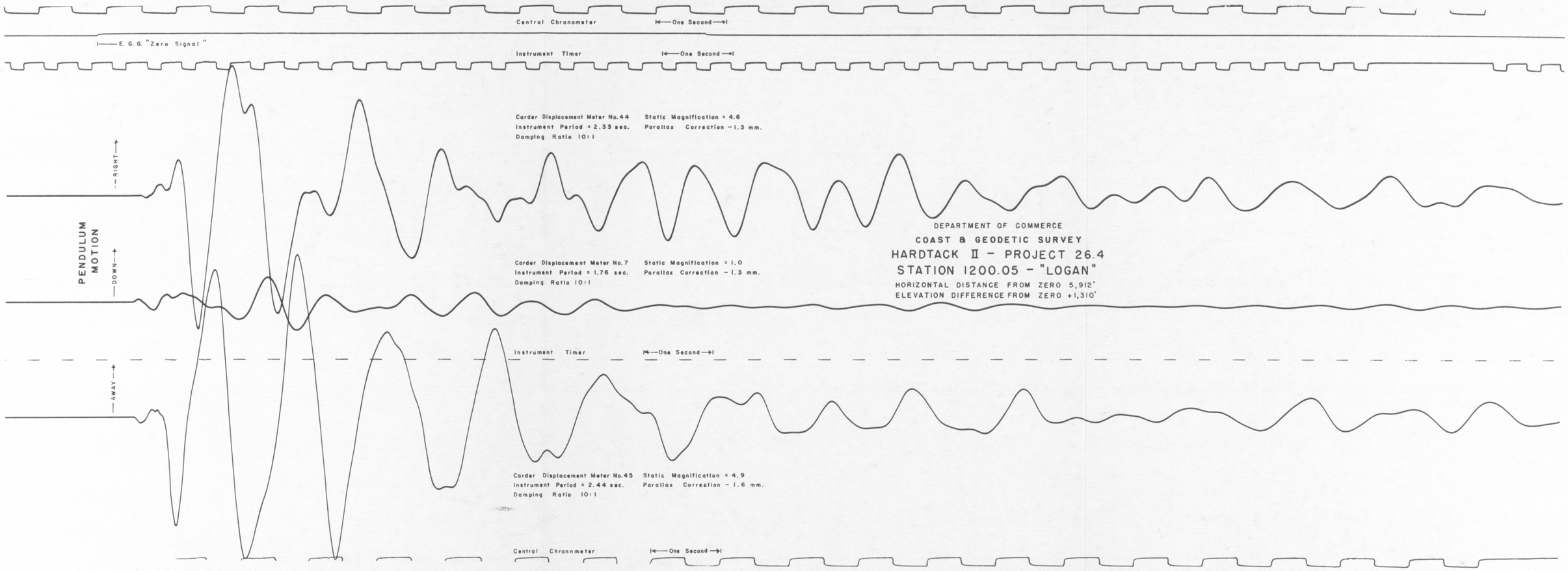


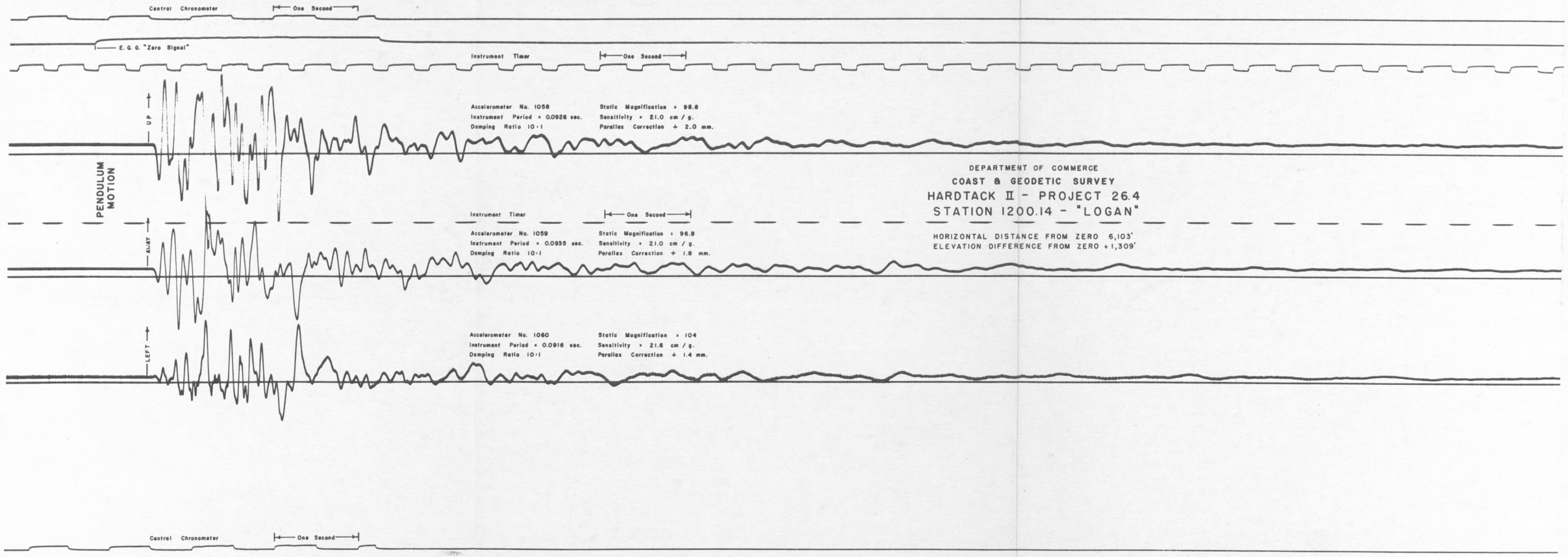
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.10 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 5,539'
ELEVATION DIFFERENCE FROM ZERO +1,264'

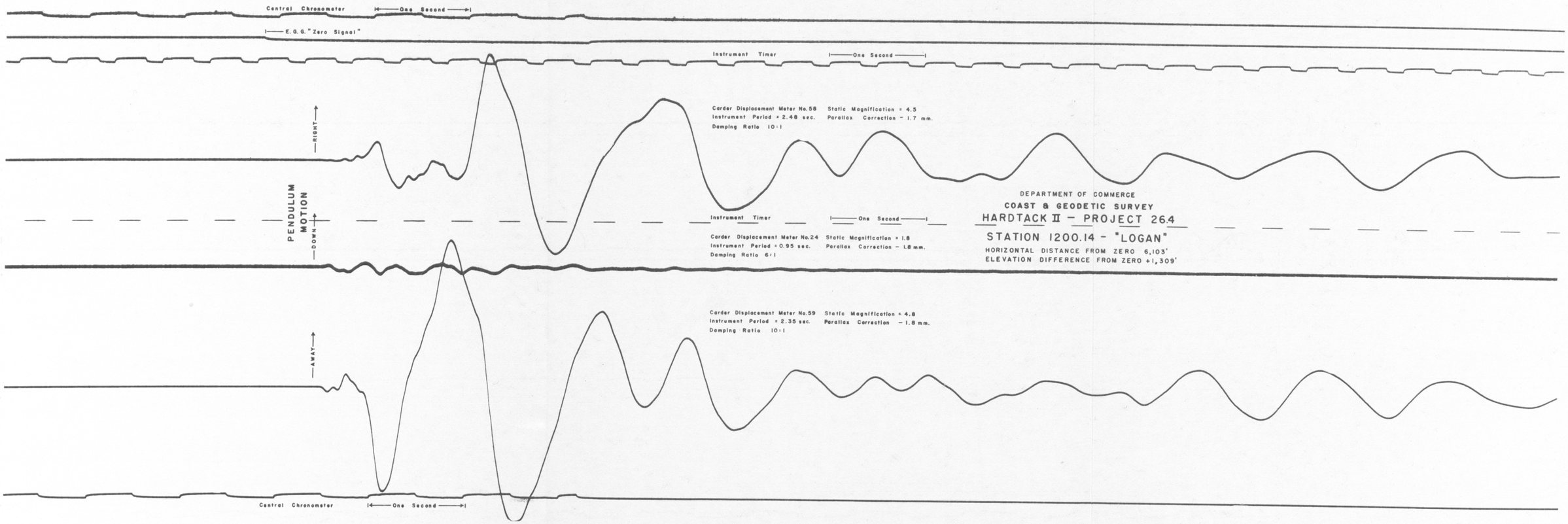

Central Chronometer
One Second
Instrument Timer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.10 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 5,559'
ELEVATION DIFFERENCE FROM ZERO +1,264'
Carder Displacement Meter No. 51
Instrument Period = 2.19 sec.
Damping Ratio 10:1
Static Magnification = 4.5
Parallax Correction - 2.7 mm.
PENDULUM MOTION
RIGHT
DOWN
Instrument Timer
One Second
Carder Displacement Meter No. 13
Instrument Period = 2.06 sec.
Damping Ratio 10:1
Static Magnification = 1.8
Parallax Correction - 2.7 mm.
AWAY
Carder Displacement Meter No. 50
Instrument Period = 2.36 sec.
Damping Ratio 10:1
Static Magnification = 4.6
Parallax Correction - 2.5 mm.
One Second
Central Chronometer

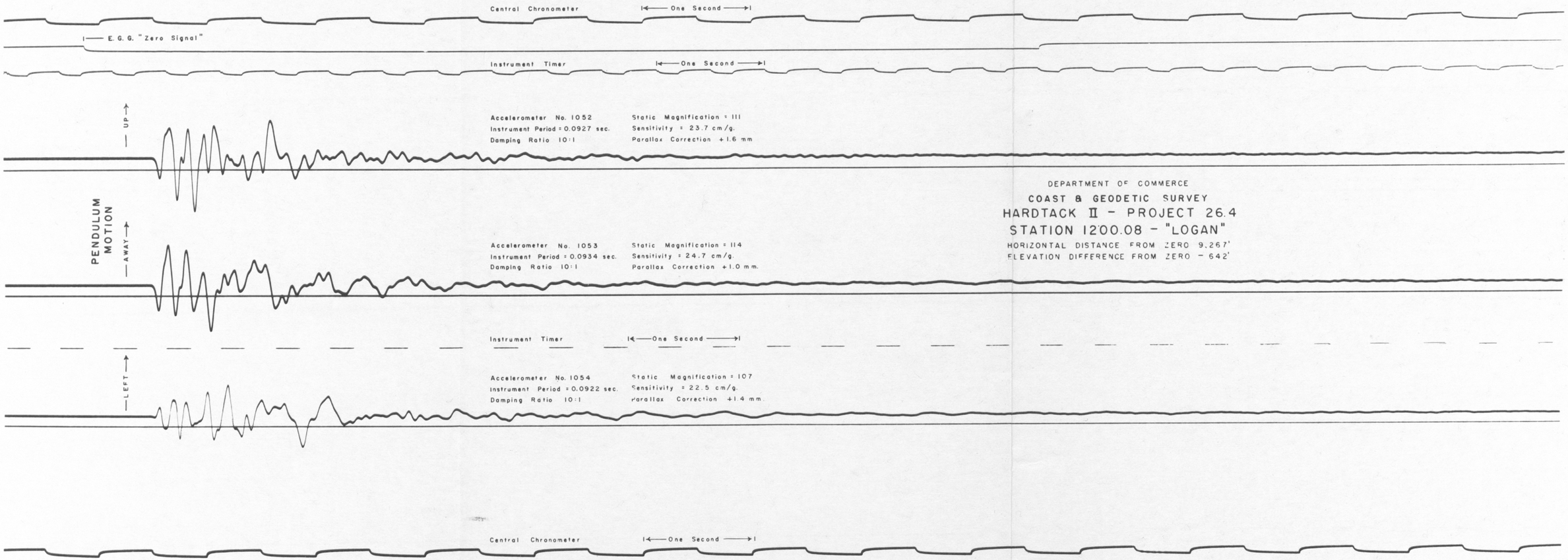


DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.05 – "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 5,912'
ELEVATION DIFFERENCE FROM ZERO +1,310'

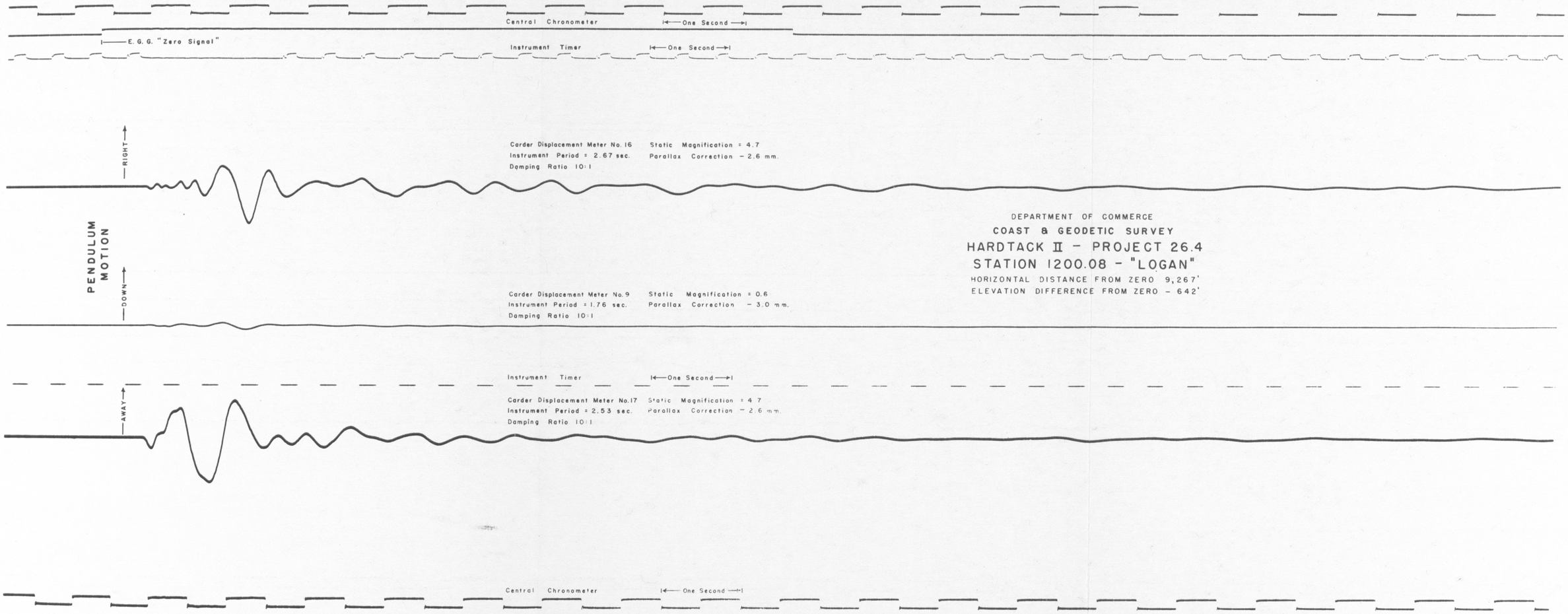

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
Carder Displacement Meter No. 44
Instrument Period = 2.33 sec.
Damping Ratio 10:1
Static Magnification = 4.6
Parallax Correction −1.3 mm.
RIGHT
PENDULUM MOTION
DOWN
Carder Displacement Meter No. 7
Instrument Period = 1.76 sec.
Damping Ratio 10:1
Static Magnification = 1.0
Parallax Correction −1.3 mm.
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.05 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 5,912'
ELEVATION DIFFERENCE FROM ZERO +1,310'
Instrument Timer
One Second
AWAY
Carder Displacement Meter No. 45
Instrument Period = 2.44 sec.
Damping Ratio 10:1
Static Magnification = 4.9
Parallax Correction − 1.6 mm.
Central Chronometer
One Second


Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
PENDULUM MOTION
UP
Accelerometer No. 1058
Instrument Period = 0.0926 sec.
Damping Ratio 10:1
Static Magnification = 98.8
Sensitivity = 21.0 cm / g.
Parallax Correction + 2.0 mm.
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.14 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 6,103'
ELEVATION DIFFERENCE FROM ZERO +1,309'
Instrument Timer
One Second
AWAY
Accelerometer No. 1059
Instrument Period = 0.0935 sec.
Damping Ratio 10:1
Static Magnification = 96.8
Sensitivity = 21.0 cm / g.
Parallax Correction + 1.8 mm.
LEFT
Accelerometer No. 1060
Instrument Period = 0.0916 sec.
Damping Ratio 10:1
Static Magnification = 104
Sensitivity = 21.6 cm / g.
Parallax Correction + 1.4 mm.
Central Chronometer
One Second

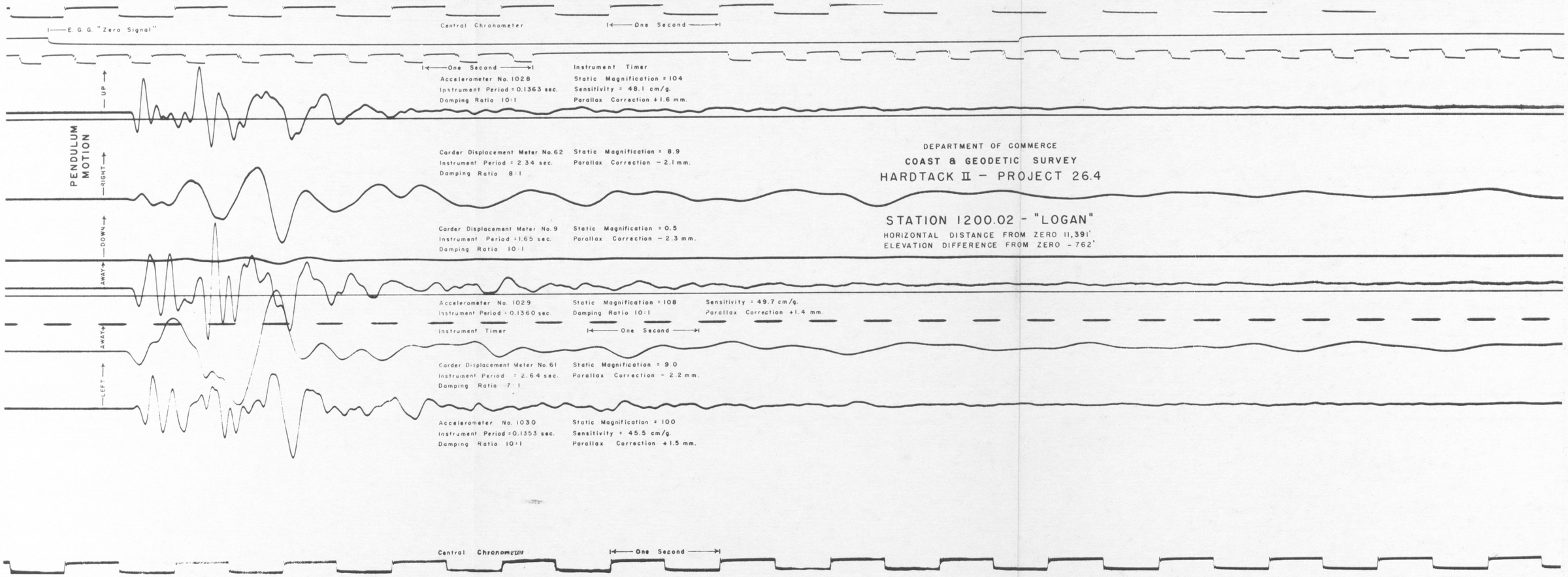

Central Chronometer
One Second
E. G. G. "Zero Signal"
Instrument Timer
One Second
Corder Displacement Meter No. 58 Static Magnification = 4.5
Instrument Period = 2.48 sec. Parallax Correction - 1.7 mm.
Damping Ratio 10:1
RIGHT
PENDULUM MOTION
DOWN
Instrument Timer
One Second
Corder Displacement Meter No. 24 Static Magnification = 1.8
Instrument Period = 0.95 sec. Parallax Correction - 1.8 mm.
Damping Ratio 6:1
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.14 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 6,103'
ELEVATION DIFFERENCE FROM ZERO +1,309'
Corder Displacement Meter No. 59 Static Magnification = 4.8
Instrument Period = 2.35 sec. Parallax Correction - 1.8 mm.
Damping Ratio 10:1
AWAY
Central Chronometer
One Second



DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.08 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 9,267'
ELEVATION DIFFERENCE FROM ZERO - 642'

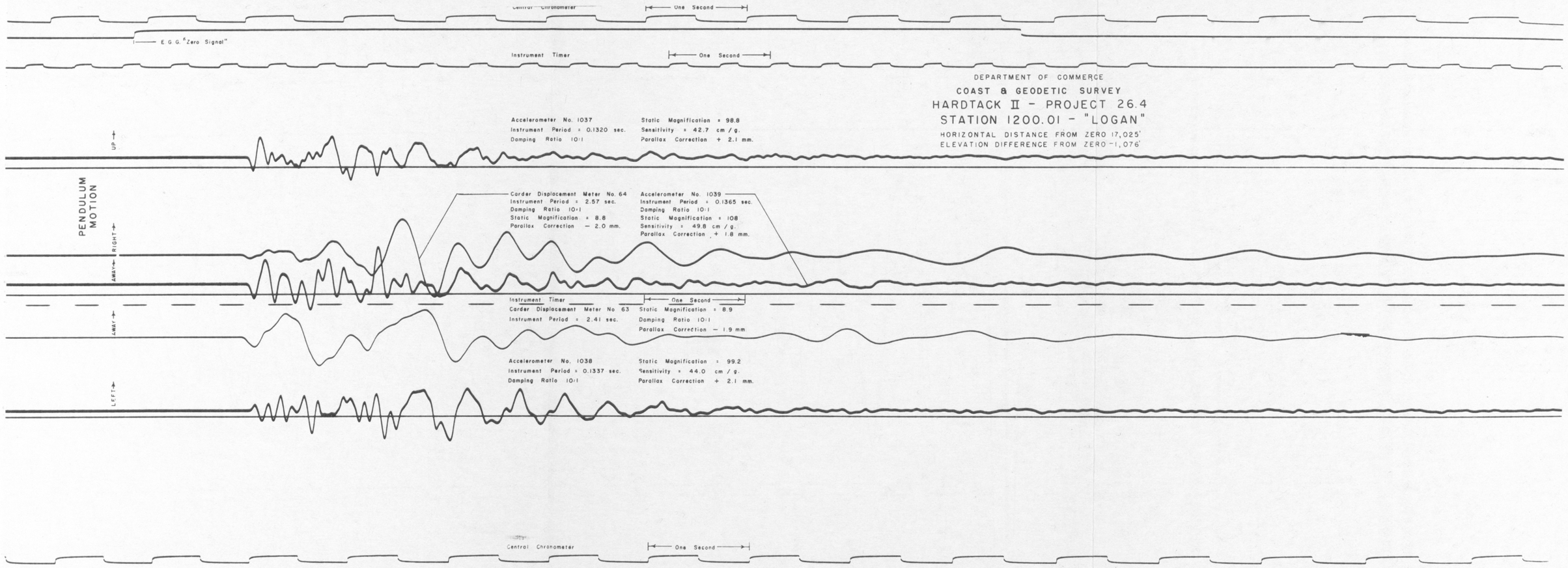


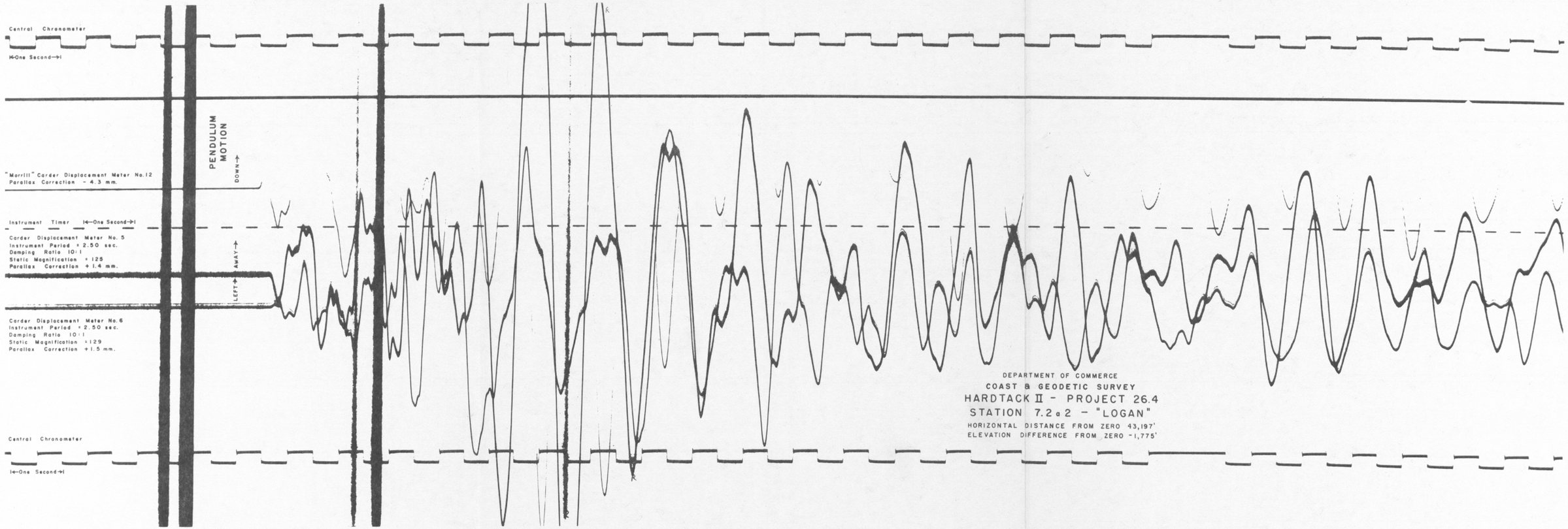
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.08 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 9,267'
ELEVATION DIFFERENCE FROM ZERO - 642'

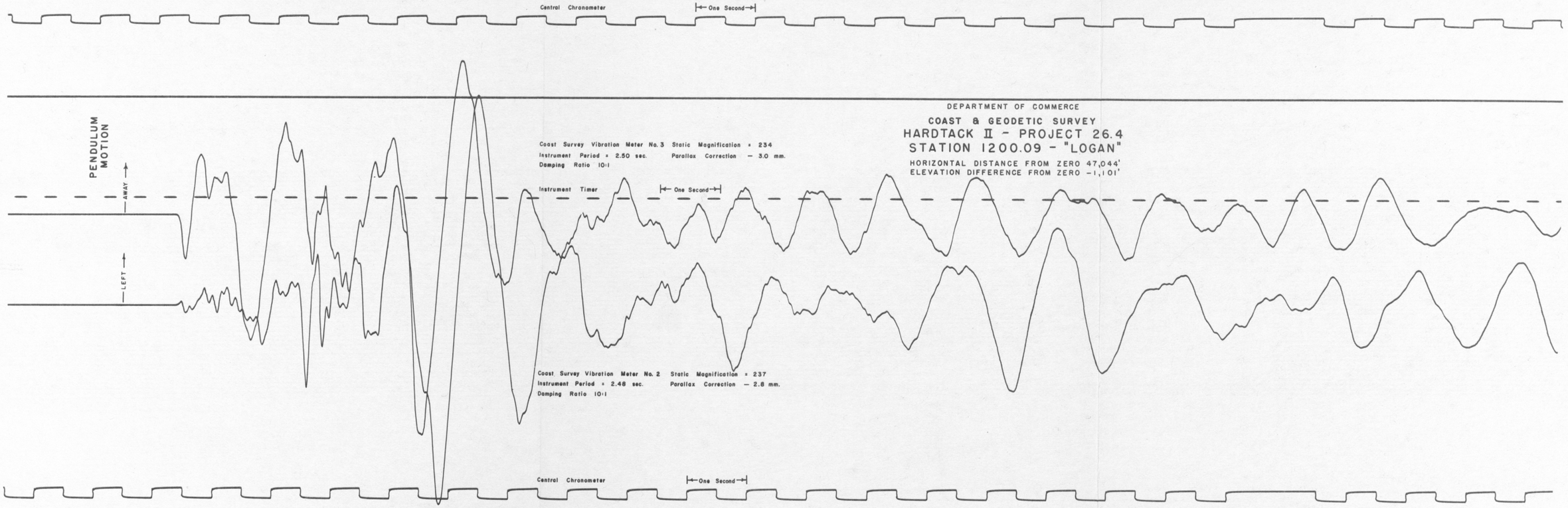


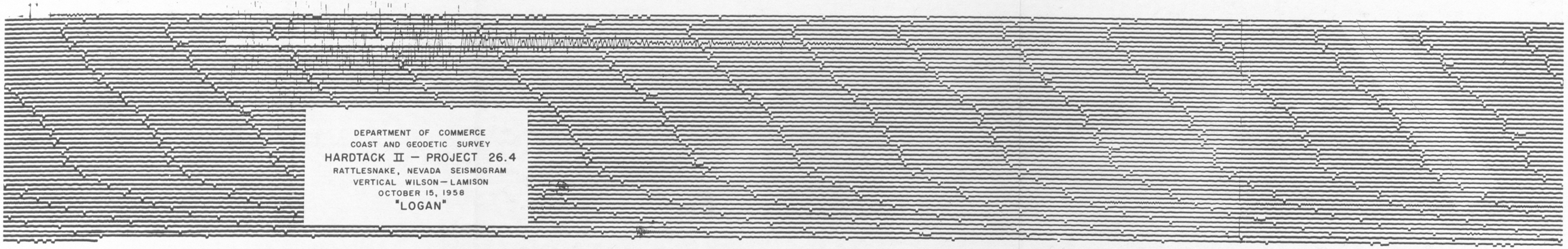
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4

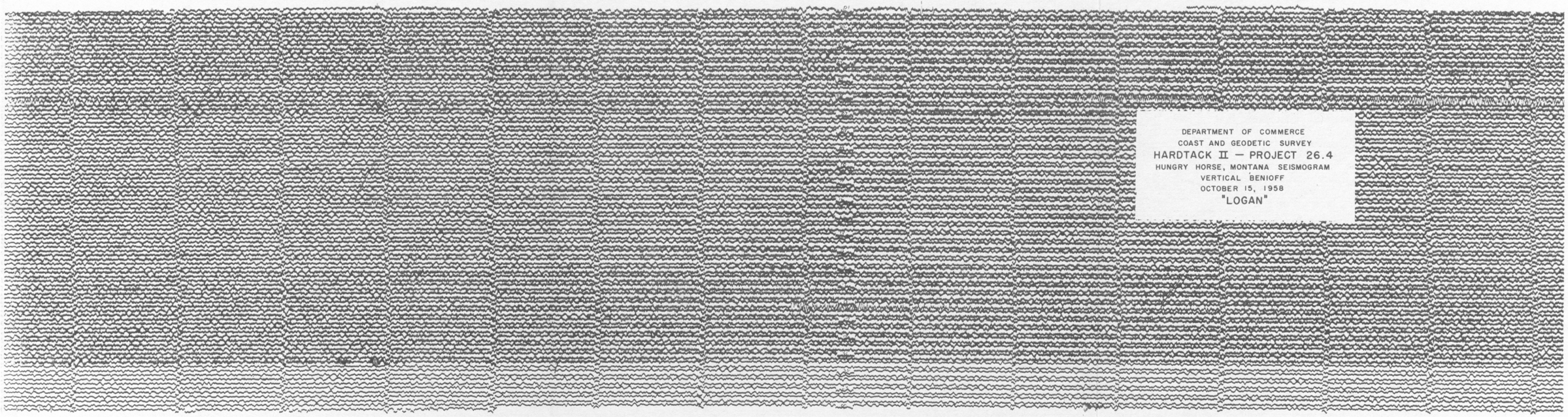
STATION 1200.02 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 11,391'
ELEVATION DIFFERENCE FROM ZERO - 762'

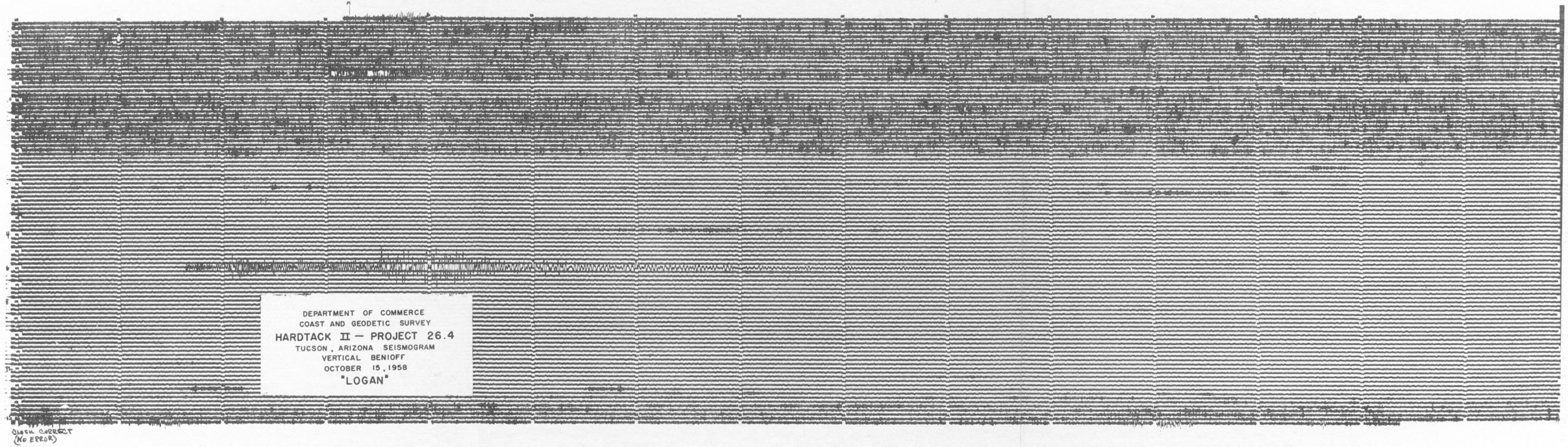

Central Chronometer
One Second
E.G.G. "Zero Signal"
Instrument Timer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.01 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 17,025'
ELEVATION DIFFERENCE FROM ZERO -1,076'
Accelerometer No. 1037
Instrument Period = 0.1320 sec.
Damping Ratio 10:1
Static Magnification = 98.8
Sensitivity = 42.7 cm / g.
Parallax Correction + 2.1 mm.
UP
PENDULUM MOTION
Carder Displacement Meter No. 64
Instrument Period = 2.57 sec.
Damping Ratio 10:1
Static Magnification = 8.8
Parallax Correction − 2.0 mm.
Accelerometer No. 1039
Instrument Period = 0.1365 sec.
Damping Ratio 10:1
Static Magnification = 108
Sensitivity = 49.8 cm / g.
Parallax Correction + 1.8 mm.
RIGHT
AWAY
Instrument Timer
One Second
Carder Displacement Meter No. 63
Instrument Period = 2.41 sec.
Static Magnification = 8.9
Damping Ratio 10:1
Parallax Correction − 1.9 mm.
AWAY
Accelerometer No. 1038
Instrument Period = 0.1337 sec.
Damping Ratio 10:1
Static Magnification = 99.2
Sensitivity = 44.0 cm / g.
Parallax Correction + 2.1 mm.
LEFT
Central Chronometer
One Second

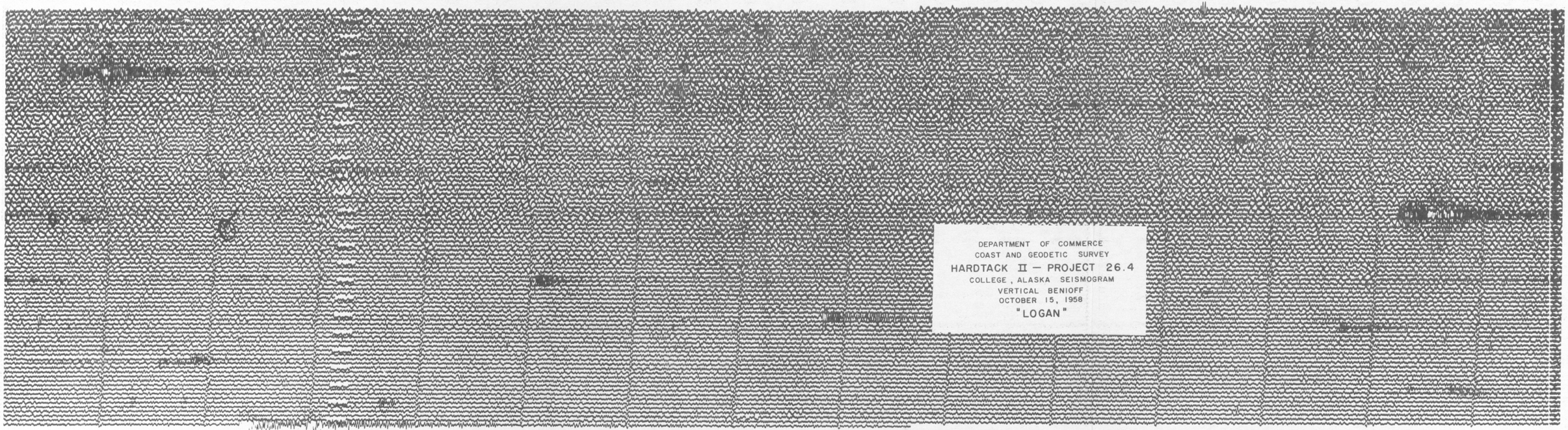

Central Chronometer
One Second
PENDULUM MOTION
DOWN
"Morrill" Corder Displacement Meter No.12
Parallax Correction - 4.3 mm.
Instrument Timer One Second
Corder Displacement Meter No. 5
Instrument Period = 2.50 sec.
Damping Ratio 10:1
Static Magnification = 125
Parallax Correction + 1.4 mm.
LEFT
AWAY
Corder Displacement Meter No.6
Instrument Period = 2.50 sec.
Damping Ratio 10:1
Static Magnification = 129
Parallax Correction + 1.5 mm.
Central Chronometer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 7.2 a 2 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 43,197'
ELEVATION DIFFERENCE FROM ZERO -1,775'

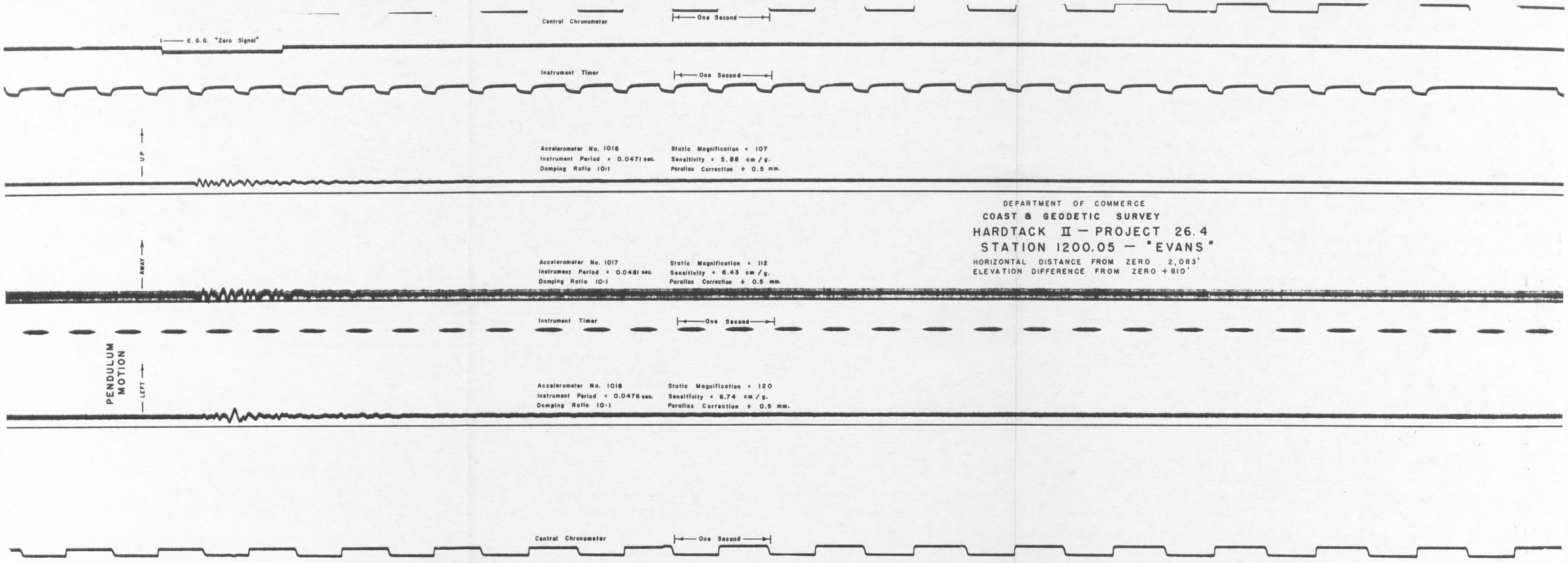

Central Chronometer
One Second
PENDULUM MOTION
AWAY
LEFT
Coast Survey Vibration Meter No. 3 Static Magnification = 234
Instrument Period = 2.50 sec. Parallax Correction — 3.0 mm.
Damping Ratio 10:1
Instrument Timer
One Second
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.09 - "LOGAN"
HORIZONTAL DISTANCE FROM ZERO 47,044'
ELEVATION DIFFERENCE FROM ZERO -1,101'
Coast Survey Vibration Meter No. 2 Static Magnification = 237
Instrument Period = 2.48 sec. Parallax Correction — 2.8 mm.
Damping Ratio 10:1
Central Chronometer
One Second


DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
RATTLESNAKE, NEVADA SEISMOGRAM
VERTICAL WILSON – LAMISON
OCTOBER 15, 1958
"LOGAN"

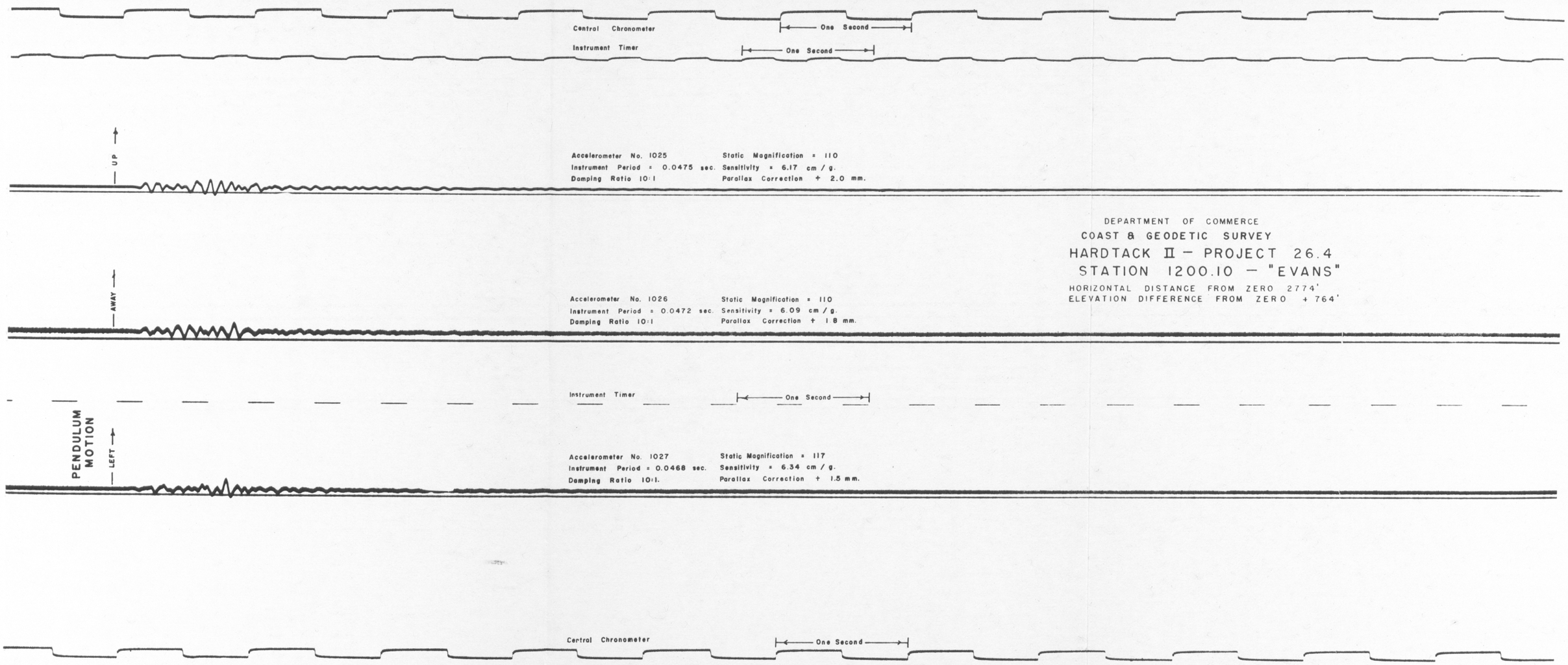

DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
HUNGRY HORSE, MONTANA SEISMOGRAM
VERTICAL BENIOFF
OCTOBER 15, 1958
"LOGAN"


DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
TUCSON, ARIZONA SEISMOGRAM
VERTICAL BENIOFF
OCTOBER 15, 1958
"LOGAN"
CLOCK CORRECT
(NO ERROR)

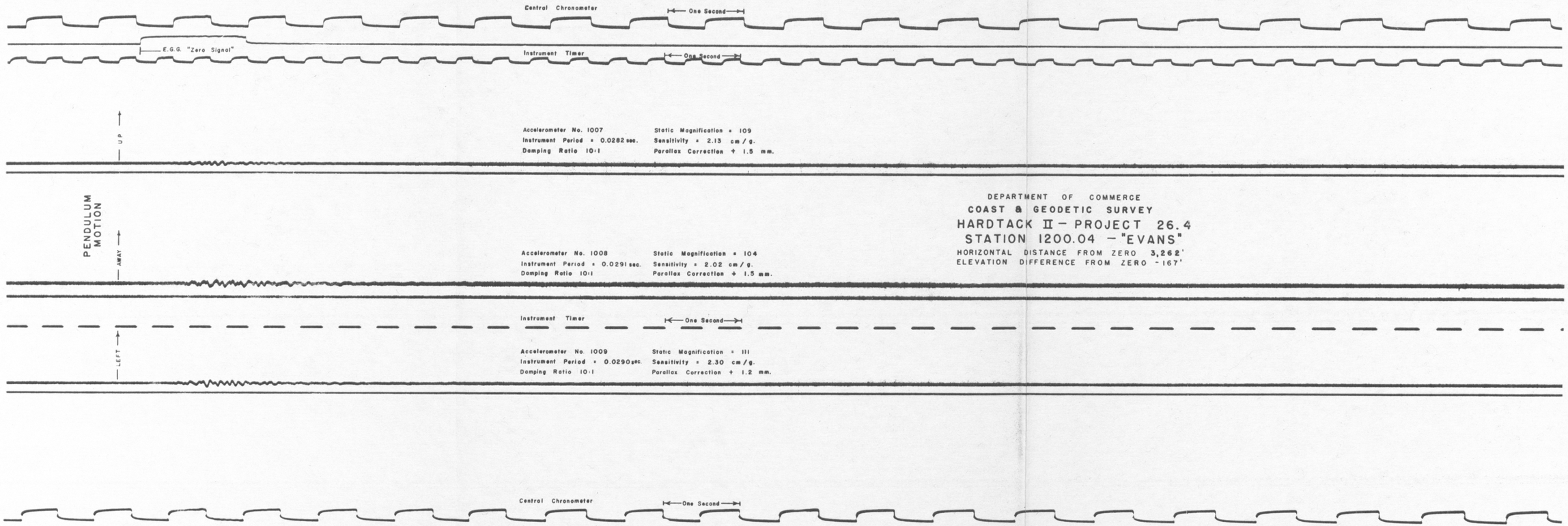

DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
COLLEGE, ALASKA SEISMOGRAM
VERTICAL BENIOFF
OCTOBER 15, 1958
"LOGAN"



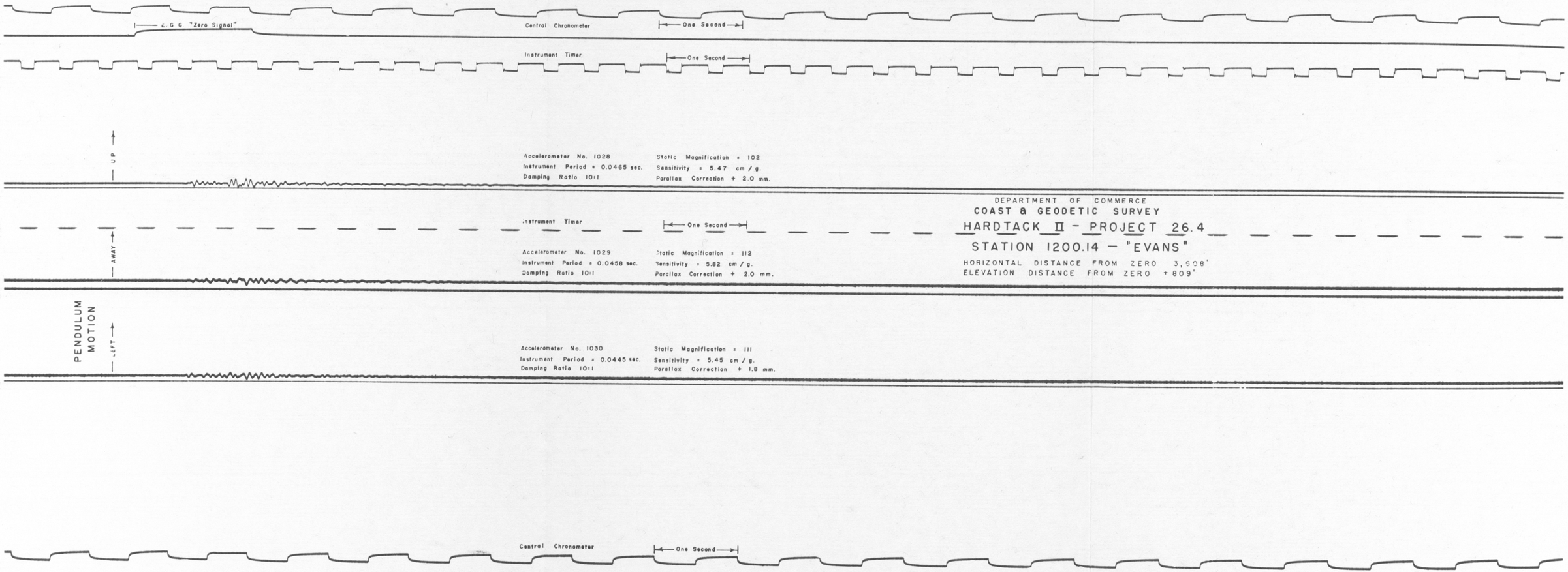
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II — PROJECT 26.4
STATION 1200.05 — "EVANS"
HORIZONTAL DISTANCE FROM ZERO 2,083'
ELEVATION DIFFERENCE FROM ZERO + 810'



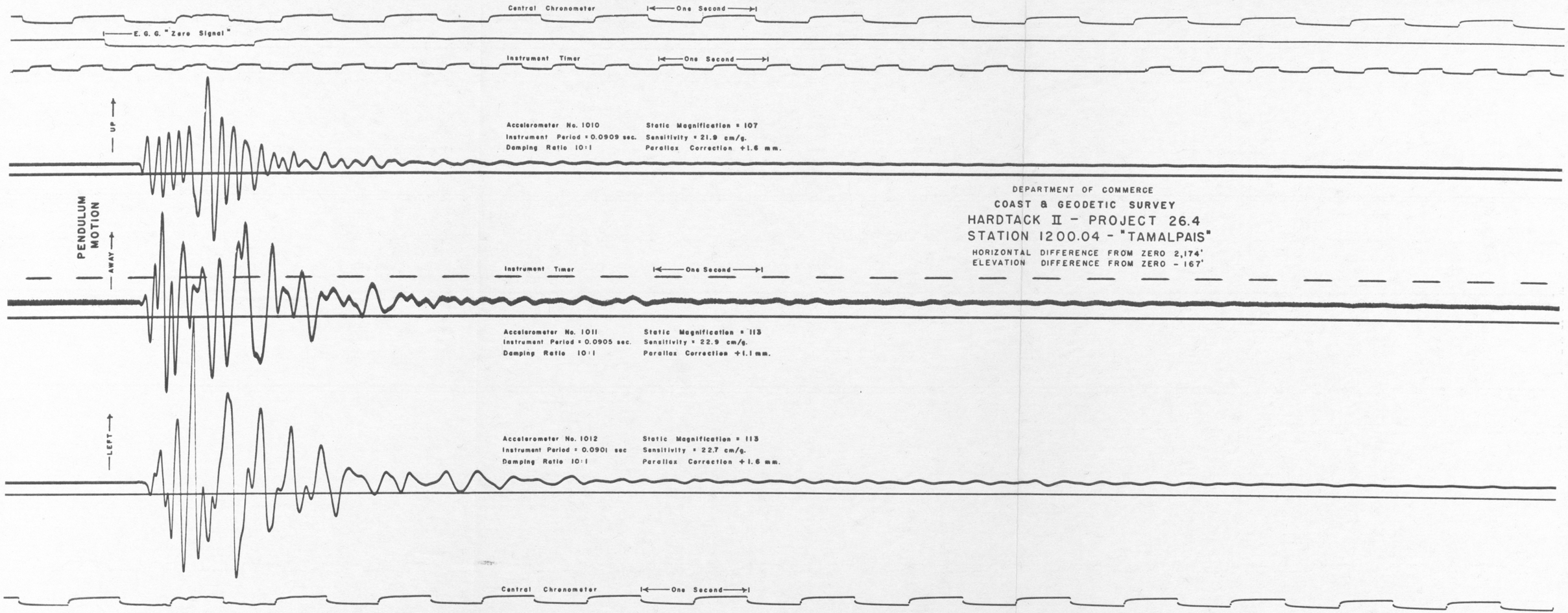
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.10 – "EVANS"
HORIZONTAL DISTANCE FROM ZERO 2774'
ELEVATION DIFFERENCE FROM ZERO + 764'



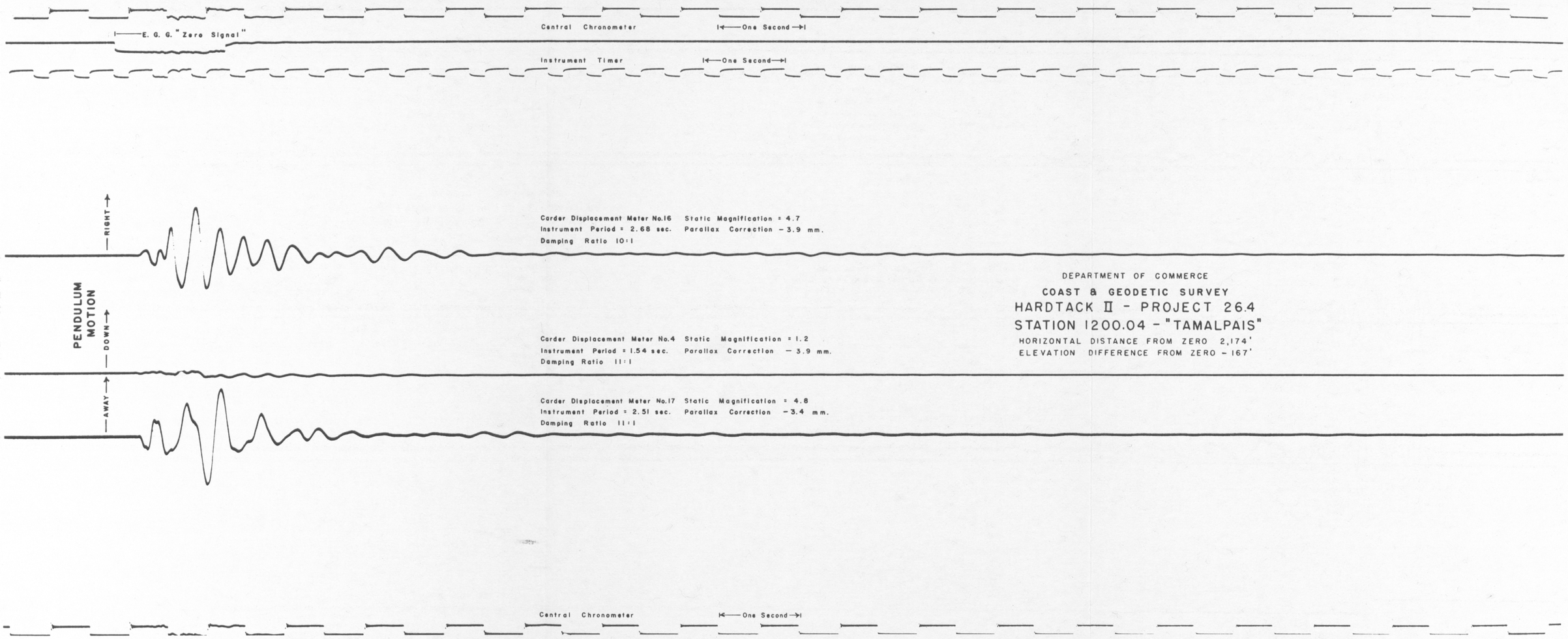
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.04 – "EVANS"
HORIZONTAL DISTANCE FROM ZERO 3,262'
ELEVATION DIFFERENCE FROM ZERO -167'



DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.14 - "EVANS"
HORIZONTAL DISTANCE FROM ZERO 3,608'
ELEVATION DISTANCE FROM ZERO +809'



DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.04 - "TAMALPAIS"
HORIZONTAL DIFFERENCE FROM ZERO 2,174'
ELEVATION DIFFERENCE FROM ZERO - 167'



DEPARTMENT OF COMMERCE

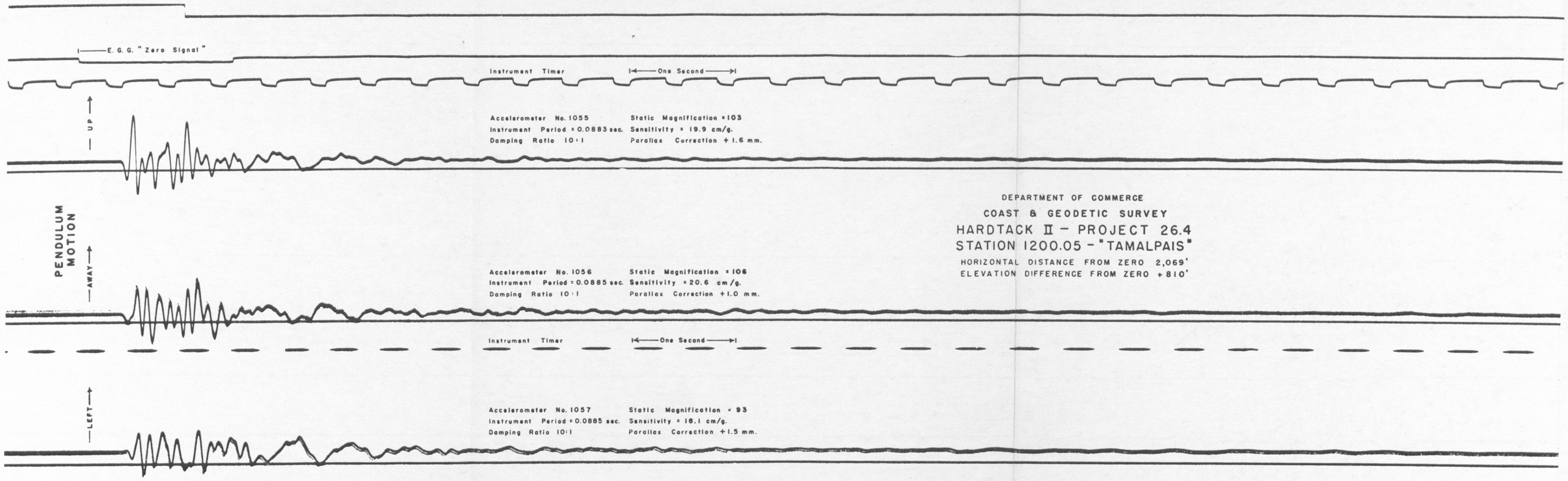
COAST & GEODETIC SURVEY

HARDTACK II - PROJECT 26.4

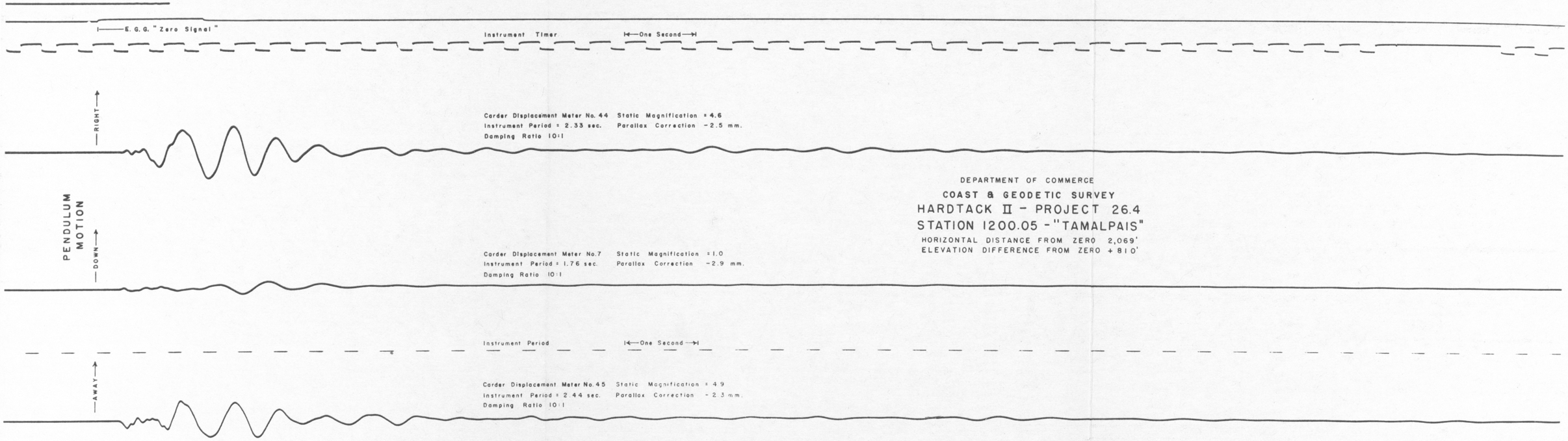
STATION 1200.04 - "TAMALPAIS"

HORIZONTAL DISTANCE FROM ZERO 2,174'

ELEVATION DIFFERENCE FROM ZERO - 167'



DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.05 – "TAMALPAIS"
HORIZONTAL DISTANCE FROM ZERO 2,069'
ELEVATION DIFFERENCE FROM ZERO + 810'



DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.05 - "TAMALPAIS"
HORIZONTAL DISTANCE FROM ZERO 2,069'
ELEVATION DIFFERENCE FROM ZERO + 810'

e, not connected as yet.

DEPARTMENT OF COMMERCE

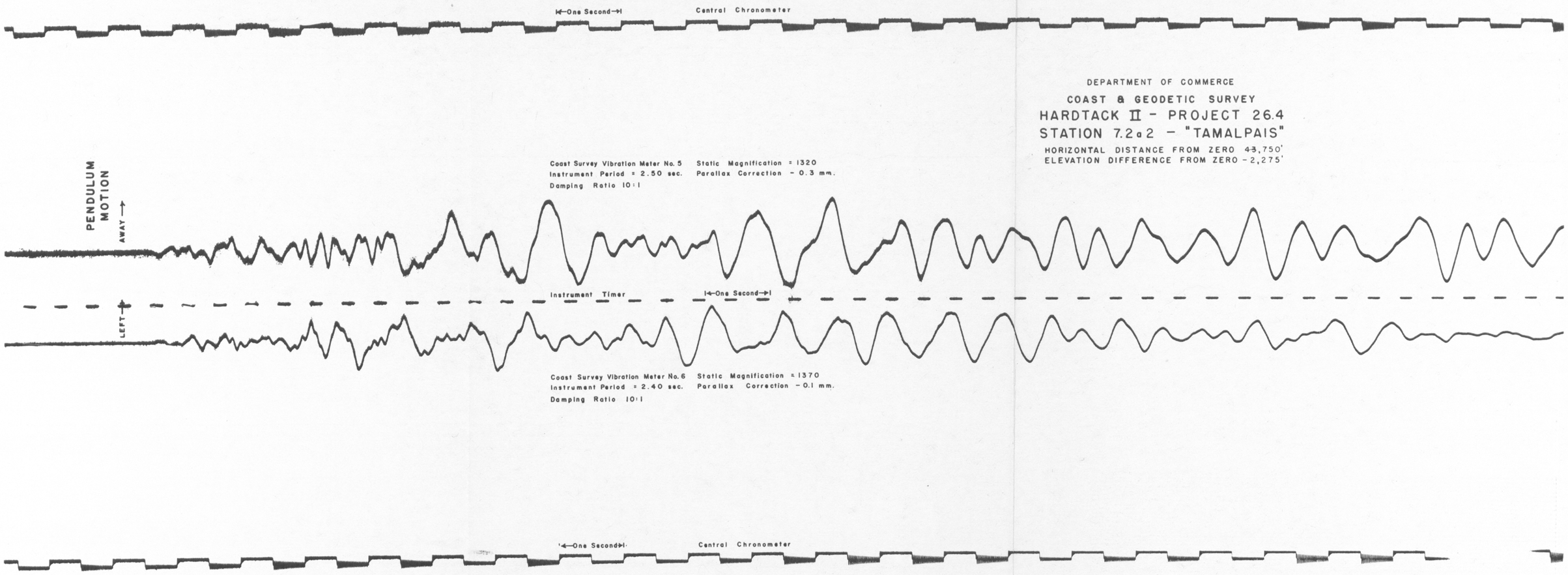
COAST & GEODETIC SURVEY

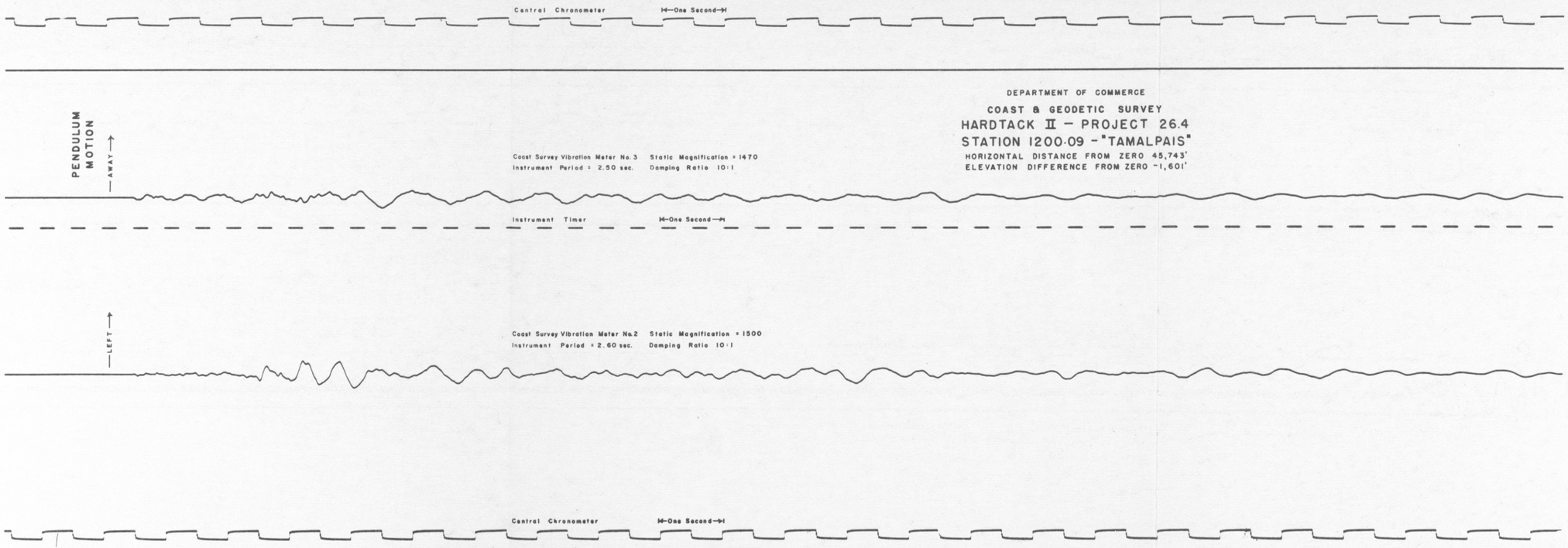
HARDTACK II - PROJECT 26.4

STATION 7.2 a 2 - "TAMALPAIS"

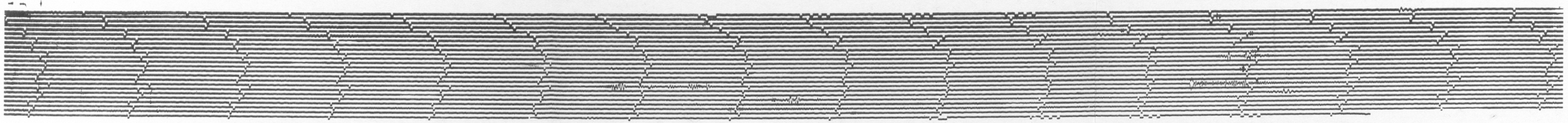
HORIZONTAL DISTANCE FROM ZERO 43,750'

ELEVATION DIFFERENCE FROM ZERO - 2,275'

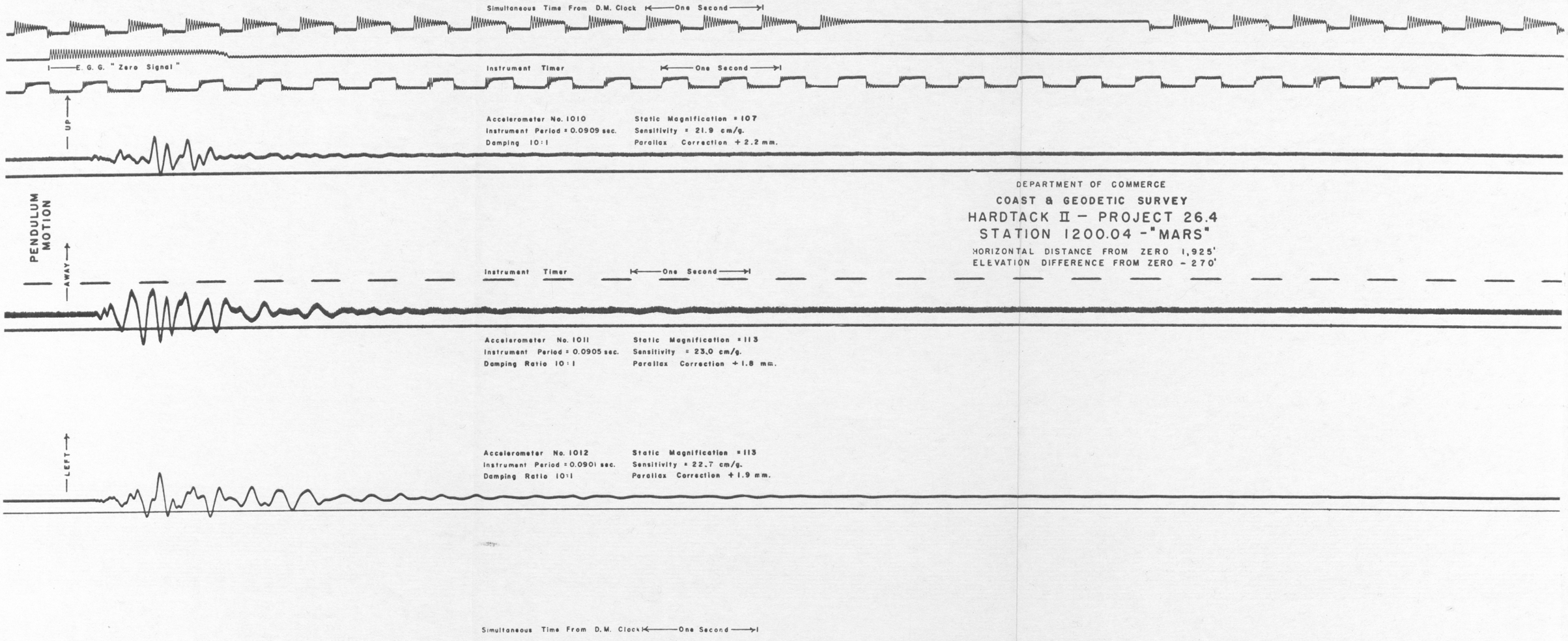




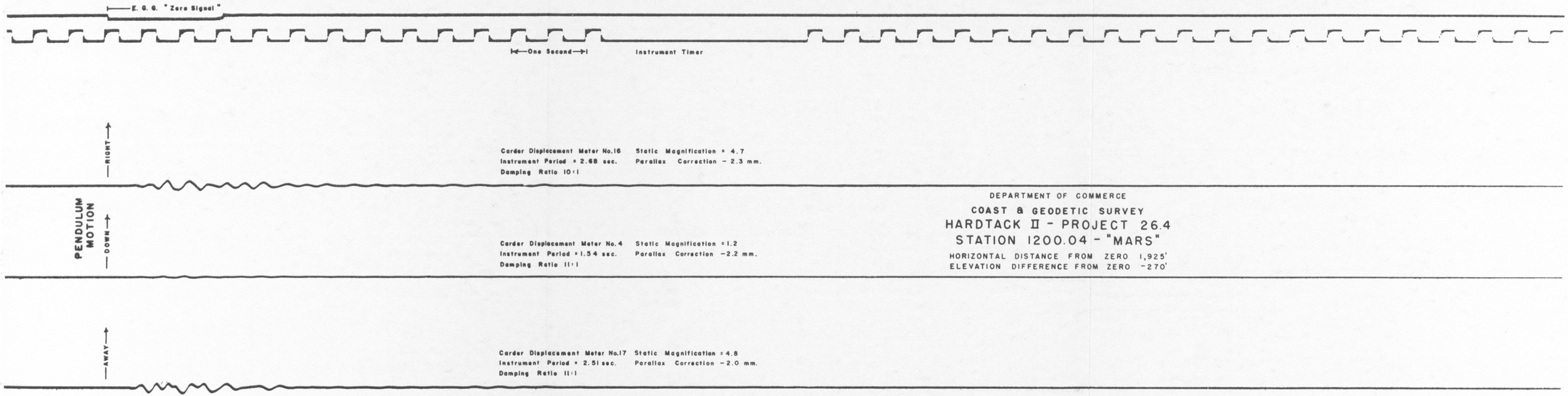
DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200-09 – "TAMALPAIS"
HORIZONTAL DISTANCE FROM ZERO 45,743'
ELEVATION DIFFERENCE FROM ZERO -1,601'



DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
RATTLESNAKE, NEVADA SEISMOGRAM
VERTICAL WILSON – LAMISON
OCTOBER 8, 1958
"TAMALPAIS"



DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II – PROJECT 26.4
STATION 1200.04 - "MARS"
HORIZONTAL DISTANCE FROM ZERO 1,925'
ELEVATION DIFFERENCE FROM ZERO - 270'



DEPARTMENT OF COMMERCE
COAST & GEODETIC SURVEY
HARDTACK II - PROJECT 26.4
STATION 1200.04 - "MARS"
HORIZONTAL DISTANCE FROM ZERO 1,925'
ELEVATION DIFFERENCE FROM ZERO -270'